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ORIGINAL ARTICLES.

I.—On a New *Ophiurella* from the Calciferous Grit, near Sandsfoot Castle, Weymouth, Dorset.[1]

By the late Dr. Thomas Wright, F.R.S., F.G.S.

(PLATE III.)

Genus Ophiurella, Agassiz, 1836.

Disk small, membranous, often indistinct, a character which separates this genus from *Ophiura*. Rays very long, slender, depressed, formed of circles of plates, four in each circle; the lateral plates are the largest, most prominent, and provided with long spines; the basal plates are small and spiniferous, and the dorsal smooth and without clothing. Mouth plates small and triangular. All the species known have been found in the Jurassic rocks.

Ophiurella nereidea, Wright, 1880. (Pl. III.)

Description.—Disk small, irregularly penta-lobed, each lobe consisting of a shield-like elevation formed by the radial plates, which are covered by a tegumentary membrane closely studded over with small granules; the interlobular integument is entirely absent, having apparently, if it ever existed, been destroyed in the process of fossilization.

The arms, or rays (five in number), are long, four times the length of the disk's diameter. They do not taper much between the radial plates and their termination, and consist of innumerable highly movable rings composed of:—1st a centro-dorsal plate, which, with its fellows, form a long, smooth, convex, continuous chain, flattened at the summit, and laid along the middle of the rays; 2nd, two rows of lateral plates which bend downwards, closely clasping the sides of the ray; each plate supporting a small tubercle, on which a stout thorn-like spine is articulated by a kind of ball and socket joint; 3rd, the basal or ventral plates which close the ray below are small and much concealed, they likewise carry short, stout spines. One of the spiniferous arms of the *Ophiurella*, as it lies on the slab of calcareous grit before me, resembles a marine worm, the *Nereis nuntia*, and hence the origin of the specific name I have ventured to give to this Brittle-star. The arms are very much bent and curled, so that this species may be said to have had highly moveable arms.

[1] Extracted from the Dorset Natural History and Antiquarian Field Club, vol. iv. p. 56, printed at the "Journal" Offices, South Street, Sherborne.

Dimensions.—Diameter of the disk six-tenths of an inch; length of arm, two inches and six-tenths. This is less than in the living state, as none of the arms are preserved up to their terminations.

Affinities and Differences.—The fragmentary condition of the disk prevents any definite conclusions as to the true generic position of this form, but it agrees with *Ophiurella* closer than with any other. It has the small disk with the upper and under surfaces flattened, the lateral and ventral plates supporting spines, which are specially jointed to the lateral plates. In all these essential generic characters it agrees with *Ophiurella*. I know of no figured species from the Corallian rocks that resembles this Brittle-star. The only form that occurs to my mind is *Ophiurella bispinosa*, d'Orb., which has only been named, but was neither described nor figured by the author. Our species is so widely different from all the others, that there can be no confusion with them.

This Brittle-star was obtained by Professor Buckman, F.G.S., from the Calciferous Grit at Sandsfoot Castle, near Weymouth.

II.—On Two Species of Palæozoic Madreporaria hitherto not recognized as British.

By Robert F. Tomes, Esq.

THE present communication is the result of the examination of a considerable number of small Silurian Corals, from Wenlock and Colwall, made as long ago as 1883, and it was written with the intention of its being communicated to the Geological Society. I very much regret, however, that circumstances have arisen which render it extremely difficult, perhaps impossible, for me to place myself again in communication with that body. The paper appears therefore in the pages of the Geological Magazine, a medium for publication which I hope from time to time to have recourse to.

Of the two species of Corals, an account of which I now lay before the readers of the Geological Magazine, one represents an entirely new genus, which I designate *Hemiphyllum*, and the other is a species of *Cyathaxonia*.

Hemiphyllum, nov. gen.

Cyathaxonia, M'Coy?

The corallum is simple, small, conical, and curved. It has a porous structure, and is surrounded by a thin epitheca, which is more or less rudimentary at the calicular extremity. There is a large and spongy columella, but no septal fossette. The calice is circular and bounded outwardly by a ring of spongy tissue, formed by spongy septa united by porous endotheca, constituting a thick and spurious wall. At the inner margin of this ring each pair of septa coalesce to form a septum, which passes across the intervening space and unites with the columella. All the septa are irregularly perforate, the punctures appearing to be due rather to their porous nature than to any regularly arranged perforations. The loculi appear to be open from the bottom to the top of the corallum.

I place this peculiar form in the vicinity of *Cyathaxonia*, though only on account of the open loculi, and am somewhat doubtful as to its real affinities. There is no true wall, and when the epitheca is worn off, the edges of the porous septa are exposed. But the absence of a wall is compensated for by the ring of endotheca which takes its place and binds the septa together outwardly.

As it is quite possible that the species on which I here propose to form a new genus is no other than the one described by M'Coy under the name of *Cyathaxonia Siluriensis*,[1] I adopt for it the specific name given by him.

HEMIPHYLLUM SILURIENSIS, M'Coy, sp.?

Cyathaxonia Siluriensis, M'Coy?

The corallum is small and cornute, the curvature being sometimes confined to the small extremity, but is more frequently uniform throughout its whole length.

The epitheca is thin, somewhat annulated, and it does not ever extend to the margin of the calice. When well developed, it has a well-defined upper margin, above which the calice projects; but when it is less complete, the upper margin is ill defined, and it does not always extend more than half-way up the corallum.

FIG. 1.

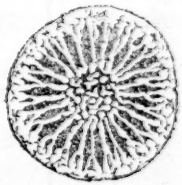


FIG. 2.

Hemiphyllum Siluriensis, M'Coy, sp.?
Magnified $2\frac{1}{4}$ times.

The calice is circular, shallow, and saucer-shaped, and when unworn the columella is nearly hidden by the septa which run into it. The outer ends of the septa project upwards, in the position usually occupied by the wall, and, with the abundant endotheca, form the margin of the calice. They are twenty-six in number, irregular in development, nearly equal in size throughout, and there is no distinction between the cycles. All of them pass inwards to the columella, the irregular papillæ of which blend with those of the septa, and the exact union of the columella and septa is obscured. The whole of the septa are perforate, but the perforations have no definite arrangement, and each septum divides into two near the

[1] Ann. and Mag. Nat. Hist. 2nd series, vol. vi. p. 281, 1850.

outside of the corallum. Their denticulations bear but little resemblance to those of the *Astræidæ* and *Fungidæ*, and more nearly resemble undulations of the septal margin than actual denticulations, and they may be due to the want of continuous development incident on an open-work septum, rather than to the termination of vertical columns or ridges, as in so many of the *Astræidæ*.

When worn down, this coral assumes a different aspect. The calice is then distinctly tri-areal. There is the outer ring of spongy endotheca, an inner circle across which the septa pass, and a large central columellary space of spongy tissue.

The largest specimen I have seen has a height of one inch, and a calice of half that diameter.

It occurs in the Upper Silurian formation at Woolhope and Wenlock, but I have only met with a limited number of specimens from those localities.

By an error in transcribing M'Coy's description of *Cyathaxonia Siluriensis*, MM. Milne Edwards and Haime give it sixty or seventy septa instead of sixteen or seventeen,[1] and the error has been repeated in their general work on Corals.[2]

CYATHAXONIA DALMANI, MM. Edwards & Haime, Mon. Polyp. Foss. des Terr. Palæon. p. 322, pl. i. fig. 6.

In a Silurian quarry at the west foot of the hill at the back of the mansion at Old Colwall, Herefordshire, the residence of Mrs. Holland, I found, on the occasion of a visit there, a considerable number of small corals which could not be referred to any known English species, but which, on examination, proved to be identical with the *Cyathaxonia Dalmani* of MM. Milne Edwards and Haime.

The strata at the place mentioned are nearly vertical, and I was unable to ascertain the position of the corals in them, though, from the manner in which they were clustered in some of the nodular lumps of stone lying in the bottom of the quarry, I did not doubt that they were confined to one bed or zone. The quarry, so far as I can ascertain by reference to the map of the Geological Survey, is either in the Aymestry limestone, or the Ludlow bed.

One specimen only of another coral, in a very bad state and as yet undetermined, was found associated with the present species.

The figured specimen of *Cyathaxonia Dalmani* was obtained from the Upper Silurian of Gothland, and was preserved in the collection of M. Verneuil; and I have in my own collection examples from Gothland with which I have compared the Herefordshire specimens, and found them to be identical.

The figures accompanying this communication represent *Hemiphyllum Siluriensis*, magnified $2\frac{1}{4}$ times. Figure 2 shows a horizontal section a little below the calice.

[1] Brit. Fos. Cor. pl. 5, p. 279.

[2] Hist. Nat. Coral. t. iii, p. 332.

III.—Notes on Some Post-Liassic Species of *Acrodus*.

By A. Smith Woodward, F.G.S., F.Z.S.,
of the British Museum (Natural History).

So little is known of the extension through later Mesozoic deposits of Selachian teeth belonging to the familiar type of *Acrodus*, as represented in the Lias, that any additional evidence upon the subject is invested with considerable interest. It is impossible, of course, from these isolated relics, to determine whether the original Sharks were as closely allied as the resemblances in their dentition might at first lead one to suspect; in one case,[1] indeed, it has been proved that the complete fish differs much from the Liassic species; but the persistence of the dental type is at any rate of some significance, and it may therefore be acceptable to offer a few notes upon the undescribed Jurassic and Cretaceous Acrodonts preserved in the British Museum. These specimens furnish evidence of at least two new specific modifications, and they are also suggestive of novel points in regard to some of those already known.

Acrodus leiodus, Agassiz, MS.

1844. *A. leiodus*, L. Agassiz, "Rech. Poiss. Foss." vol. i. p. xxxiii (name only).
1871. *Acrodus*, J. Phillips, "Geol. of Oxford," p. 177, fig. 10.

In the recently acquired collections of Sir Philip Egerton and the Earl of Enniskillen, there are several teeth from Stonesfield bearing the name of *Acrodus leiodus* in Agassiz' own handwriting; and these may consequently be regarded as the types of the species intended to be so described in one of the projected supplements of the "Poissons Fossiles." The form, however, appears to have remained hitherto undefined, and the only allusion to it that I have succeeded in discovering occurs in Prof. Phillips' work quoted above.

The Egerton specimens (No. P. 2134) are very unsatisfactory—two being much broken, and the third somewhat waterworn—but two of those in the Enniskillen Collection (No. P. 2753) and others in the Museum are in a comparatively good state of preservation. The species is but a small one, as indicated by the annexed woodcut (Fig. 1), which is twice natural size, and the teeth vary considerably in shape, according to their original situation in the jaw; some are much elongated and relatively narrow, being referable to a posterior position, while others, evidently pertaining to the symphysial area, are notably short and broad. It is interesting to remark, also, that even the latter are destitute of any prominent rising of the coronal surface, and there are but slight traces of lateral points or cusps. All the less abraded examples show a very characteristic surface-ornament, consisting of large and rounded ridges, closely approximated, and disposed in the ordinary manner;

Fig. 1. Tooth of *Acrodus leiodus*, Ag. Twice natural size. Great Oolite, Minchinhampton. [Byne Coll., Brit. Mus.]

[1] A. Wagner, "Monographie der fossilen Fische aus den lithographischen Schiefern Bayerns," Abh. k. bayer. Akad. d. Wiss. cl. ii.; vol. ix. pp. 300-304, pl. v. fig. 1.

and these seem to be most nearly paralleled in the smaller species, *A. minimus*, which occurs so abundantly in the Rhætic formation.

From those of *A. leiopleurus*, the present teeth are readily distinguished by the flatness of the grinding surface, and the rounded character of the ornamental rugæ. And there can be no doubt of their distinctness from *A. falcifer* of the Solenhofen Lithographic Stone, for Wagner's specimen of the last-named species has every appearance of being adult, and yet has teeth of much smaller size: while there is good evidence, also, that in the present Bathonian form the symphysial teeth were rounded and not acuminate.

Formation and Locality.—Great Oolite—Stonesfield, Minchinhampton; Forest Marble—Atford near Bath.

A. LEIOPLEURUS, Agassiz ("Rech. Poiss. Foss." vol. iii. p. 145, pl. 22, fig. 5).

This species is founded upon a single tooth in the Bristol Museum, supposed to have been derived from the Great Oolite; and its chief characteristics are the height of the crown and the angularity of the ornamental wrinkles upon its surface. A beautifully perfect tooth from the Great Oolite of Minchinhampton, preserved in the Byne Collection, appears to be referable to the same form, only differing in the extension of the ornament over the lateral prominences; and it seems not improbable that this slight divergence depends merely upon the abraded character of the original type specimen.

A. ELEGANS, Sauvage (Mém. Acad. Boulogne-sur-Mer, vol. ii. 1867, p. 54, pl. iii. fig. 9).

From the Great Oolite of Caen, Normandy; appears to be wrongly placed in the genus under consideration. The few specimens available for study leave little doubt that they belong to a species of *Strophodus*. It ought, however, to be added, that satisfactory evidence of the complete dentition of the latter genus has only been obtained since Dr. Sauvage's original description.

A. HIRUDO, Agassiz ("Rech. Poiss. Foss." vol. iii. p. 148, pl. 22, fig. 27).

The type specimen of this form is said to be preserved in Dr. Mantell's collection, but was not received among the fossils sent to the British Museum. A very characteristic tooth, however, from the Wealden of Telham Hill, near Battle, has recently been presented by John Edward Lee, Esq., F.G.S., and this (No. P. 4994) seems worthy of a passing note. The summit has been considerably abraded, so that the longitudinal wrinkle of the enamelled surface is represented rather as a faint groove; but numerous very fine corrugations are directed transversely outwards on either side, exactly as remarked in Agassiz' original description. The coronal surface has a remarkably unusual contour, being distinctly concave in the median portion, and rising into a slightly tumid prominence at either extremity.

A. LEVIS, sp. nov.

None of the Cretaceous teeth hitherto described under the name

of *Acrodus* exhibit any very close resemblance to the typical forms from the Trias and Lias; and it is therefore of considerable interest to be able to record some most characteristic examples of this dental type from the Gault of Folkestone. The British Museum possesses about nine well-preserved specimens, obtained from the Gardner Collection, and it requires but a brief examination to recognize their distinctness from all previously described species. The teeth are of comparatively small size, and vary considerably in form according to their original situation in the jaw; examples that are evidently referable to the symphysial area are short, with much-raised crowns, and indications of lateral cusps (Fig. 2); while those from posterior positions (Fig. 3) are more elongated and have the coronal surface

Fig. 2.

Fig. 3.

Figs. 2, 3. Anterior and posterior teeth of *Acrodus levis*, A. S. Woodw. Twice natural size. Gault, Folkestone. [Gardner Coll., Brit. Mus.]

gently rounded and showing but little elevation. The superficial ornament consists of sharp wrinkles disposed in the ordinary manner, but relatively far apart, and never approaching a reticulate arrangement; and in most cases the rugæ do not extend far down upon the sides of the crown, so that there is a noticeable smoothness of the enamel, which suggests the appropriate specific name of *levis*.

Formation and Locality.—Gault—Folkestone.

A. transversus, Agassiz ("Rech. Poiss. Foss." vol. iii. p. 148, pl. 22, figs. 28, 29).

A. polydyctios, Reuss ("Verstein. böhm. Kreideform." pt. ii. p. 97, pl. xxi. figs. 1–8).

A. cretaceus, Dixon ("Geol. and Foss. Sussex," 1st edit. p. 364, pl. xxx. fig. 13).

There can be no doubt that the species described under the above names are founded upon teeth of *Drepanephorus*. Agassiz himself admitted (*l.c.* p. 149) that the first of the three forms exhibited noteworthy deviations from the typical early Mesozoic species of *Acrodus*, and might be generically distinct; and later discoveries have now established this original surmise as a fact. All the teeth have the characteristic median ridge of those occupying the more posterior positions in *Drepanephorus*, and there is the same well-marked ornamentation—numerous fine rugæ descending on either side from the ridge and passing more or less abruptly into a complex and delicate network. To the first-named species, which was founded upon teeth from the Maestricht Beds, may probably be referred a well-preserved specimen obtained from the Chalk of Lewes by the late Dr. Mantell, and also one other small fragment from the same locality. The root is not displayed, so that it is impossible to determine whether there is the curious perforation noted by Egerton in

the teeth of *D. canaliculatus*; nor is it possible, upon such fragmentary materials, to formulate any very definite specific diagnosis. The *A. polydyctios* of Reuss is evidently rather smaller, and may be distinct; but the figure of the tooth made known by Dixon as *A. cretaceus* does not suffice to distinguish it from Egerton's fossil already mentioned and I have not seen the type.

A. Illingworthi, Dixon ("Geol. and Foss. Sussex," 1st ed. p. 364, pl. xxx. figs. 11, 12, and pl. xxxii. fig. 9.)

From an examination of the detached teeth of this species, it is impossible to determine whether it is to be referred to the generic type under consideration, or ought rather to be placed with those Cretaceous teeth hitherto regarded as pertaining to *Hybodus*. The National Collection comprises a small group of about twelve naturally associated examples, but this does not afford any information as to the character of the complete dentition; and the discovery of further specimens must be awaited before it is possible to arrive at any definite conclusions. In form, the English fossils are remarkably similar to some minute teeth described by Reuss from the Chalk of Bohemia, under the name of *Hybodus polyptychus*.[1]

As already mentioned, comparatively satisfactory remains of at least one post-Liassic Selachian, with teeth of the *Acrodus*-type, have been described by Wagner (*loc. cit.*) from the Lithographic Stone (or Lower Kimmeridgian) of Solenhofen, under the name of *A. falcifer*. This species, however, differs so much from the typical forms of Liassic age, that it seems not unlikely that future discoveries may lead to its generic separation; the dentition, for example, is less uniform, the symphysial teeth being conical and pointed; the dorsal spines and shagreen are quite different, and there are no dermal "*Sphenonchi*" in the cephalic region; and there is considerable reason for suspecting that the vertebral column attains a much higher stage of development.

It seems also very probable that some of the species described above, upon mere dental evidence, may eventually prove to be equally distinct. As regards the Jurassic and Wealden forms, of course, it is quite possible that they were Sharks of the ordinary type as represented in the Lias; for both ribbed dorsal spines and dermal hooklets (*Sphenonchi*) are not unfrequently met with in the same deposits. But since none of these appendages can be distinguished from those of the true *Hybodus*, and since also there are numerous Hybodont teeth upon the same horizons, it is equally probable that they all pertain to the latter.

In Cretaceous formations, however, dorsal spines with a ribbed ornamentation are almost entirely wanting; Owen's *Hybodus complanatus*,[2] in fact, appears to be the only example hitherto described,

[1] A. E. Reuss, "Verstein. böhm. Kreideform." pt. ii. p. 97, pl xxi. figs. 9, 10.

[2] R. Owen, "Notes on Two Ichthyodorulites hitherto undescribed," Geol. Mag. Vol. VI. 1869, p 482. The small fragments in Dr. Mantell's Collection, said to have been obtained from the Chalk of Lewes, and described by Agassiz (*op. cit.* vol. iii. p. 44, pl. 10*b*, figs. 15, 16) as *Hybodus sulcatus*, are undoubtedly Wealden fossils: see S. J. Mackie, "The Geologist," vol. vi. p. 242.

and this is not of later date than the Neocomian; and, so far as is known, there are no traces of the curious hooked *Sphenonchi*. But a small smooth spine, originally described by Agassiz under the name of *Spinax major*,[1] is quite commonly discovered both in the Gault, Greensand, and Chalk; and its remarkable resemblance to the homologous appendage of the Solenhofen Acrodont is very suggestive of its true correlation, in part, with the new species of *Acrodus* recorded in the foregoing notes. This spine, of course, has already been proved to characterize the *Drepanephorus* of Egerton;[2] but it is not in the least unusual for the dorsal fins of distinct genera to be armed with dermal weapons of an essentially similar type. And it is interesting to add, in this connection, that *Acrodus levis* and *Drepanephorus canaliculatus* are almost certainly members of the same family of Cestraciontidæ, the last-named form having been originally referred in error to the Spinacidæ, as is shown by the asterospondylic structure of its vertebral centra.[3]

IV.—The Faunas of the Ffynnon Beuno Caves, and of the Norfolk Forest Bed.

By Henry Hicks, M.D., F.R.S., F.G.S.

FROM Mr. Newton's letter in the February Number of the Geological Magazine, I am inclined to think that he has somewhat misunderstood my meaning where I referred to the fauna of the Norfolk Forest Bed in my paper in the December Number. Prof. Hughes had stated in his paper that the bones from the caverns "belong to the newer group of animals found elsewhere in undoubtedly Post-Glacial river deposits." As Mr. Newton admits "that most of these species have been found in the Pre-Glacial Forest Bed of Norfolk, and it is probable that others of them will yet be found," it is clear that I was correct in my contention that "a very large proportion of the animals occur in the Norfolk Forest Bed." My remarks, however, were not intended to claim the Forest Bed fauna as necessarily of the same age as the remains obtained from the caverns (though on careful analysis they are found to be much more closely allied than is usually supposed), but rather to point out that some highly important questions connected with the compulsory migration of animals in consequence of climatic changes are not taken sufficiently into consideration in these discussions, and also to show the fallacy of any such idea as that species suddenly jumped into existence to mark special stages in Geological history. Surely the species of Northern origin lived where the conditions were suitable for them long before this country was much affected by the gradually advancing glacial conditions, and only arrived here as the increasing severity of the climate compelled them to migrate further

[1] L. Agassiz, "Rech. Poiss. Foss." vol. iii. p. 62, pl. 10*b*, figs. 8–14.

[2] Sir Philip Egerton, "Figures and Descriptions of British Organic Remains, Dec. xiii." (Mem. Geol. Surv. 1872), pl. ix.

[3] C. Hasse, "Paläontologische Streifzüge im British Museum," Neues Jahrb. 1883, pt. ii. p. 66.

south. We may, therefore, legitimately assume that ancestors of the Pleistocene animals of Northern origin (probably also Man) must have been in existence somewhere during the time the Pliocene deposits were accumulating in the south-east, for it is generally admitted that the cold crept slowly over this country from the north, and that there was much land with high mountain ranges in the north and north-west during Pliocene times. It is important to remember also that wherever Reindeer remains have been found, there also we find traces of Man.

Although Man probably reached this country from the east, it seems to me equally clear that he must also have arrived here with the Reindeer from some northern source during the advance of glacial conditions. A fauna therefore which would be Interglacial in the north would be Pre-Glacial for some of the areas further south. The Forest Bed Fauna is specially interesting in showing the southward extension of some northern mammalia such as the Glutton, Mammoth, and (according to Prof. Boyd Dawkins), the Musk Sheep, before glacial conditions had actually affected that area, and the absence from it of the Reindeer and Woolly Rhinoceros is only what might be expected, as most of the herbivorous animals would naturally keep near to the edge of the advancing ice and in the mountain valleys, until driven to the southern areas by the increased cold towards the climax of the Ice age. The apparent absence of the Lion is easily accounted for, since its remains, like those of the Hyæna, are chiefly found in caverns which were their dens, and where they died.[1] It must not be forgotten also that the Forest Bed contains the fauna of an eastern, not of a western, area, as the river on the banks of which the animals roamed flowed from the south-east. Moreover, the conditions in the north and north-west were such during Pliocene time as would not tempt the more southern forms to migrate there. If Pliocene deposits occurred in the north and north-west, it is strange that no traces of them are now anywhere to be seen, or that some of the remains should not be found re-deposited in the Drift. The Pliocene fauna throughout shows that the climate was during that period becoming gradually colder, and the Forest Bed fauna is a further indication of an important stage in the onward advance of the ice. Some lists recently published by Mr. Jukes-Browne[2] demonstrate this very forcibly. They show that of the Mammalia of the Pliocene, seventeen only are found in the Forest Bed, and of these no less than seven, namely, *Hippopotamus major*, *Rhinoceros megarhinus*, *Elephas antiquus*, *Cervus elaphus*, *Equus caballus*, *Machairodus latidens*, and *Castor europæus*, pass up into the Pleistocene. Of those which appeared for the first time in the Forest Bed, twenty-one ranged to newer beds, seven species of Deer and *Caprovis Savinii* being the only forms not known as yet in the Pleistocene. All the Mollusca of the Forest Bed pass up into the newer beds. If the

[1] Mr. W. Davies mentions (Catalogue of Sir Antonio Brady's Collection, p. xxxiii) that "as we might expect from the known habits of the *Felidæ*, their remains are comparatively rare in all aqueous deposits, being more generally found in caves and rock fissures."

[2] Historical Geology, pp. 499 and 500.

Forest Bed is proved to be of Pre-Glacial age, because it is covered by Glacial deposits, then certainly we can claim the remains found in the Ffynnon Beuno Caves to be of Pre-Glacial age, since they also were completely covered over by undoubted glacial deposits, and the fact that the mammalian fauna of the Caverns would "lead one to assign to it a Pleistocene" age is certainly no proof against such a conclusion.

V.—On the Beds Containing the Gelinden Flora.

By J. Starkie Gardner, F.L.S., F.G.S.

THE Gelinden Flora, described by Saporta and Marion (Mém. de l'Acad. de Belge, t. 37; and Révision de la Flore Heersienne de Gélinden, *ibid.*, t. 41), has assumed an immense importance owing to the fact that it alone, among Tertiary fossil floras whose age is definitely ascertained on stratigraphical and palæontological grounds, contains certain remarkable types of leaves which are common to it, to the inter-basaltic beds of Glenarm in Antrim, and to Atanekerdluk in Greenland. Two of these are long lanceolate leaves, with three or more parallel mid-ribs. The larger, called *Daphnogene*, is confined in Greenland to the so-called Miocene at Atanekerdluk and to the horizon from which the collections of McClintock, Whymper, Robert Brown, and Colomb were obtained; but the smaller, *McClintockia*, has been met with in the so-called Cretaceous as well. There is some variety in the latter, the number of mid-ribs varying, and the margin being either toothed or smooth. The *McClintockia* is also the more common in Antrim, being equally found at Ballintoy and Ballypalady. The venation is very peculiar, and appears to represent an early type still preserved in phyllodes, bracts, and sepals, but almost lost in true leaves, though a not dissimilar plan is to be found in a few herbaceous plants such as the Plantain, Peony, etc. The splendid specimens which I had the good fortune to find, after draining the disused mine at Glenarm, prove beyond doubt that they were true deciduous leaves, with long and distinctly articulated foot-stalks. The *McClintockia* was originally placed in the Proteaceæ by Heer, but subsequently removed to the Urticeæ, where both types undoubtedly belong. The *Daphnogene* in fact seems to almost still exist in the *Debugesia* of the Himalayas. The presence of these types in the Heersien alone, of all the innumerable stages of the Tertiary in Europe which have yielded fossil plants, shows so far that they are characteristic of one definite horizon only, and in the absence of any evidence to the contrary, it is to this horizon and no other that the floras of Antrim and Greenland containing these plants must be referred. If palæontological evidence of such nature is not to be accepted, when there is absolutely nothing to urge against it, the basis of geology would be sapped and common-sense rules ignored.

The Gelinden plants are preserved in a fine white chalky limestone. My friend, Mons. Th. Lefèvre, of Brussels, was instrumental in procuring me a fine series, now in the British Museum; but as I

am personally unacquainted with the district, I have induced my friend Mr. G. F. Harris, F.G.S., to send the following notes upon it. The importance of a true appreciation of the evidence upon which the age of the plants is based is apparent, when it is considered that at the present moment the relative ages of the whole of the immense Tertiary formations of Ireland, Scotland, and Greenland rest almost solely upon it. This fact is brought into strong relief in my paper on the beds of Ardtun Head, Mull, read before the Geological Society on the 12th January, and further insistance upon it here is therefore unnecessary.

On the Gelinden Beds, etc.

By Geo. F. Harris, F.G.S.

Gelinden is a village about a mile and a half N.W. of Heers in Limbourg. The formation in which the flora occurs is called by the Belgian geologists Heersien supérieur; and the pit whence the great majority of the plants came from is very close to Overbroeck, about three-quarters of a mile due south of Gelinden.

On the opposite page is a geological map of the district, scale $\frac{1}{20000}$ (about $3\frac{1}{2}$ inches to the mile).

It will be observed that the section near Overbroeck is just off an outlier. The main mass, however, is close by, and the section in the "*Heersien*" is in fact in the valley of the Molen Beck, which cuts the outlier from the main mass. The *Landenien* beds thus thin out on the outlier, and their greatest thickness on it is probably not more than 3m. 40. I am nearly certain that no fossils have been found in the Lower Landenien beds on this outlier, but on the main mass, just a little N.W. of Gelinden, fossils occur in them, and the beds are thus easily identified. The base of the Landenien beds here is a more or less hard greenish sand.

The Heersien beds in the pit at Overbroeck are a pure whitish grey "marne," 10m.[1] thick, fossiliferous (especially towards the base). The base presents rather larger "bancs" than the other parts, but it is very much cracked up. The "bancs" towards the top are hard. The following fossils[2] have been found in the marne:—

Cycloides incisus.	*Lamna elegans*, sp ?
Osmeroides belgicus.	*Callorhynchus*, sp. ?
Smerdis Heersensis.	*Natica Deshayesiana*?

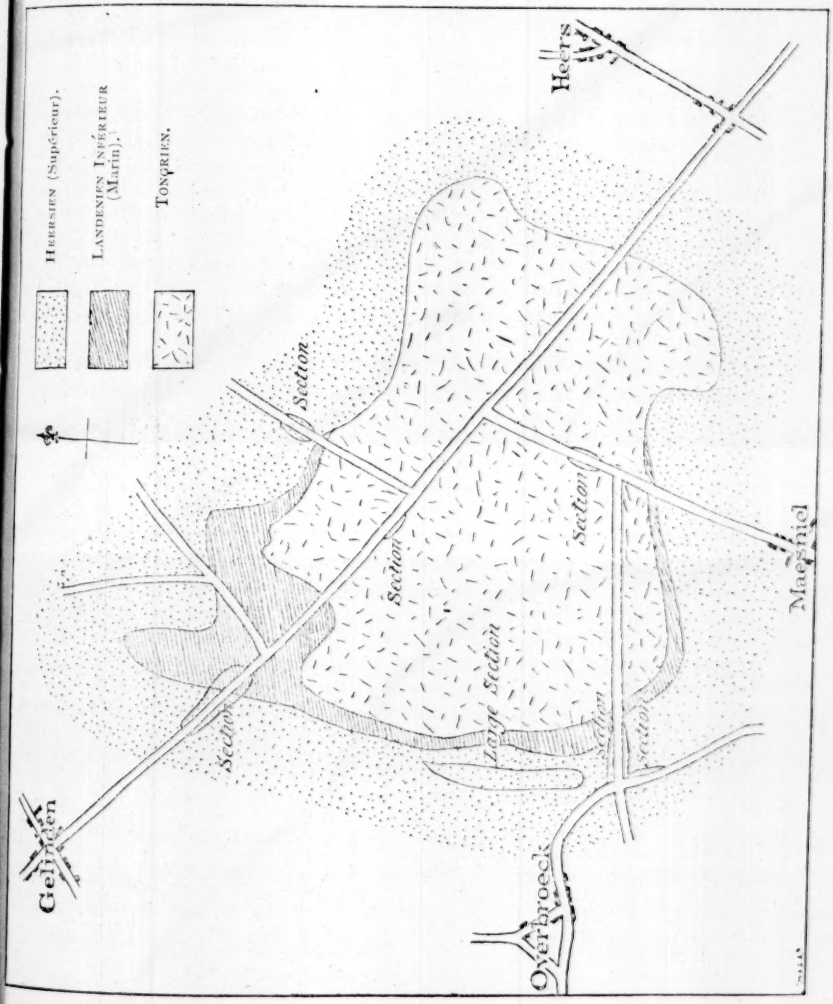
[1] The following analysis is by M. Laminne, of Tongres. Analyse de la marne de Gelinden, 100 parties de marne de Gelinden renferment:—

Carb. de chaux mélangé d'un peu de carb. de magnésie	71·290
Phosphate de chaux	0·141
Sulfate de soude; sulfate de chaux; chlorure de sodium	0·155
Silice soluble	0·170
Sable, argile et oxyde de fer	26·612
Matière organique	1·380
Ammoniaque	traces

(Extracted from "Explication de la feuille de Heers," by Rutot and Van den Broeck (1884), p. 125.) Marne of exactly similar appearance is found in many Belgian Eocene beds, even up to the Bruxellien. It usually occurs in bands more or less divided by sands (often false-bedded).

[2] Rutot and Van den Broeck, *op. cit.* p. 21.

Chenopus (*Aporrhais*) *dispar*.
Teredo, sp. ?
Panopæa triplicata.
Pholadomya cuneata.
Cytherea orbicularis.
Cytherea, sp. ?
Cyprina Morrisii.
——— *transversa*.
——— *acuminata*.
Astarte inæquilatera (*A. tenera*, syn.).
Nucula Ryckholtiana.
——— *lanceata*
——— *quadrangula*.
Cucullæa crassatina (*C. decussata*, syn.).
Modiola Heersensis.
——— *subcarinata*.
Mytilus gelindenensis.
Ostrea inaspecta.
Spongiaire, sp. ?



Besides the above, 59 species of fossil plants have been found on the same horizon in this pit, described by de Saporta and Marion.

There is not the slightest doubt, therefore, that the flora is entombed in marine strata.

Everywhere, in the district under consideration, the Heersien beds rest unconformably on Maestrichtien.

Now, with regard to the position of the flora with reference to English beds.

The fauna of the Heersien Supérieur of Belgium is a very poor one, there being but few species, and they are all very badly preserved, with the exception of the fish teeth. There are only 23 species of Molluscs in them, unless others have been discovered within the last year. Of these at least eight are found in our Thanet beds. These are:—*Cyprina planata, Cucullæa decussata, Modiola elegans, Cyprina Morrisii, Astarte tenera, Cytherea orbicularis, Nucula Bowerbankii,* and *Pholadomya cuneata.* All these, with the exception of *N. Bowerbankii,* are very common in the Heersien (as far as that term "common" can apply), whilst it is a curious fact that the remaining species are *exceedingly rare.* In other words, Thanet fossils are the characteristic ones. If the Heersien Supérieur beds contained as many species as our Thanet, we should then be in a better position to get out a percentage; but as we have only, comparatively speaking, negative evidence to go upon, I think that the general facies should rule the day, and in this case this is decidedly a Thanet facies. I have no hesitation in making the beds which entomb the Gelinden flora, then, homotaxial with the lower part of our Thanet beds, and cannot see the slightest particle of evidence—as far as the fauna shows—for making them any older.

The Landenien beds overlie the Heersien. They are divided into two parts, an upper and a lower. The lower part—Landénien Inférieur—is marine; and contains in Belgium at least 105 species of fossils, many of which have not yet been described. The Landénien Inférieur are generally admitted to be the Belgian equivalents of our Thanet beds; but whilst thinking they in part represent them, I am inclined to believe that they in part also represent newer beds. There are only 12 species of Molluscs common to our Thanet beds. These are:—*Ficula Smithii* (?), *Scalaria Bowerbankii, Ostrea bellovacina, Modiola elegans, Cucullæa crassatina, Nucula Bowerbankii, Astarte inæquilatera* (*tenera*), *Cytherea orbicularis, Cyprina planata, Sanguinolaria Edvardsii, Corbula regulbiensis, Pholadomya Koninckii*; five of these are rare. There are 10 London Clay species in all:—

Beloptera Levesquei.
Aturia zic-zac.
Ficula Smithi (?).
Ostrea bellovacina.
Pinna affinis.
Modiola elegans.
Nucula Bowerbankii.
Cyprina planata.
Corbula regulbiensis.
Panopæa intermedia.

and nine are met with in the Oldhaven Sands:—

Scalaria Bowerbankii.
Ostrea bellovacina.
Modiola elegans.
Astarte tenera.
Cytherea bellovacina.
Cytherea obicularis.
Sanguinolaria Edvardsii.
Corbula regulbiensis.
Panopæa intermedia.

Not so much reliance, however, can be placed on the actual species as on the general facies in this case. The Landénien Inférieur beds contain 12 species of *Pleurotoma*, 1 *Voluta*, 6 *Natica*, 5 *Cerithium*, 2 *Turritella*, 2 *Solarium*, 2 *Arca*, 2 *Crassatella*, 1 *Nautilus*, 1 *Neæra*, etc., a fauna quite unlike that of the Thanet beds.

Wherever the Landénien Inférieur comes in contact with the underlying Heersien beds in the many sections I have seen, I have not noticed a true unconformability, though there is occasionally an overlap. The sand is sometimes coarse, otherwise the passage, from a stratigraphical point of view, is quite conformable. When the Landénien beds rest on the Calcaire Grossier de Mons, or on the Cretaceous beds, there is in the former case generally a pebble bed at the base, and in the latter green-coated flints, the same as we see in the London Basin. This bed of green-coated flints is present wherever the Tertiary beds, Heersien and Landénien, touch the Cretaceous. It is seen also in many parts of France occupying the same position.

With respect to the Landénien Supérieur beds of Belgium, they are generally regarded as the equivalents of our Woolwich and Reading beds. *The only places in Belgium* where molluscs from the Landénien Supérieur beds have been met with are in the artesian wells at Ostend and Ghent. There are only nine species of fossils in all. These are *Melania inquinata*, *Melanopsis buccinoides*, *Cerithium funatum*, *Ostrea bellovacina*, *O. tenera*, *Cyrena cuneiformis*, *C. antiqua*, *Mytilus*, sp., and *Cliona erodens*. The Landénien Supérieur beds are so deeply seated when fossiliferous, that it is with great difficulty that they can be identified when they crop out at the surface. The only fossils I have met with from them in an outcrop is a piece of silicified wood and tubes of Annelides. I may mention that the general character of much of the Landénien Supérieur beds in Belgium is such as to cause some geologists there to think it not only fluvio-marine or freshwater, but marine.

I regard the greater part of the Landénien Supérieur beds as being part of the Landénien Inférieur, for reasons I will not enter upon now.

VI.—An Outlier of Upper Bagshot Sands on London Clay.

By the Rev. A. Irving, B.Sc., B.A., F.G.S.

THE chief object of this paper is to describe an unmapped outlier of Bagshot Sand, in which the pebble-bed, frequently met with at this level,[1] exhibits an extraordinary thickness and compactness. It is situated at Bearwood, on the estate of John Walter, Esq., who has kindly given me every facility for investigating it. The extent of the outlier may be said to coincide approximately with the space enclosed within the 250 foot contour-line of the Six-Inch Ordnance Survey Map. On the south side it extends a little way to the south of that line, in the form of several spurs forming low ridges, the principal of which is crossed, and partly cut through, by the main

[1] See Proceedings of Geol. Assoc., vol. viii. pp. 149—151; Q.J.G.S., vol. xli. (Aug. 1885), p. 508; Proc. Geol. Assoc. vol. ix. pp. 219, 223, 224.

road from Arborfield Cross to Wokingham. The highest point on this outlier is on Birtle Heath, where it is capped with Quaternary Drift, containing an intermixture of rounded flint pebbles and subangular discoloured flints, and partaking therefore of the general character of the plateau gravels of this district. Close by Barkham Lodge (at the south-east corner of Bearwood Park) the altitude is marked on the Survey Map 280 above O.D. The well at Barkham Lodge is 40 feet deep; and as this well in all probability reaches the water-bearing line at the top of the London Clay, we may take this as representing very nearly the greatest thickness of the sands of this outlier, together with the capping of later Drift. Bearwood House is situated at an altitude of 240 feet, a little way off the mass of Bagshot Sands, and stands on a drift-gravel, consisting of pebbles and subangular fragments of flint embedded in a matrix of sand, of the same character as that which forms the mass of the outlier. I had a good opportunity during the summer of examining a section of this in a wide open trench across the yard of the house. The two feet of made earth at the top was well marked off from the gravelly sand below, which was seen resting at depths of from 4 to 6 feet upon an eroded surface of London Clay,[1] which could be identified with certainty, although it had lost its character as "blue-clay" by oxidation to a bright brown red. The large lake in Bearwood Park, about 50 feet lower than the house, lies in a hollow of the London Clay.

The Pebble-Bed.

The best exposure of this *in situ* is in a "gravel-pit," about a quarter of a mile to the south-west of Barkham Lodge, just behind a small group of cottages, which stand in the angle of the roads. At the present time some hundreds of tons of flint pebbles, and nothing but flint pebbles, may be seen lying in heaps in this pit, the pebbles being of various sizes from that of a hazel-nut up to large pebbles measuring 6 × 4 × 2 inches. Nothing can exceed the smoothness and regularity of their contour. In the face of the quarry the pebble-bed is exposed in a horizontal band from 2 to 3 feet in thickness. The pebbles are closely huddled together, as closely as the Bunter pebbles are in the well-known quarries in Sutton Park, near Birmingham, which during the last meeting of the British Association I had the pleasure of examining in company with Mr. Harrison. They are enclosed in a greenish sandy matrix, precisely like that in which the pebbles are embedded at some points in the cutting north of Wellington College Station, about four miles distant from this section. The boundary-line between the pebble-bed and the bed of Bagshot Sand which comes immediately above it is as sharp and well defined as anything can possibly be. The latter bed is a strong loamy sand, very ferruginous and rather coarse in grain; so loamy that on weathering it flakes off on the face of the section, and its outline becomes somewhat rounded. The beds

[1] Proved depth 256 feet. See Mem. Geol. Survey, vol. iv. p. 423. Compare my paper in Geol. Mag. for September, 1886.

exposed in the pit pass northward under the hill-slope, which is occupied by a ploughed field. On the southern side of the quarry a bed *beneath* the pebble-bed is exposed; and the lithological resemblance between this and the bed exposed beneath the pebble-bed[1] in the railway-cutting at Wellington College Station is very striking. I subjoin a diagram of the section as it is exposed in the gravel-pit, of which a description has just been given. The full thickness of the pebble-bed and the nature of the subjacent bed on the north side were proved by an excavation which Mr. Walter was good enough to have made for me.

I am aware that several very competent geologists, whose opportunities for detailed observation of the stratigraphy of the Bagshot Series have been but limited, are very sceptical as to the existence of veritable Bagshot pebble-beds, since in many instances, these beds have been examined at the present surface, where, in arresting further denudation, they have often got somewhat reconstructed and mixed up with a few discoloured subangular fragments of flint (which belong to the later Quaternary Drift, and are easily recognizable); but I am quite sure that such scepticism would be removed by an inspection of this Barkham pit. The pit was re-opened only last winter, after having been disused for years, and getting quite overgrown with weeds and brambles. The pebble-bed crops out in great force in the gardens of the adjoining cottages, and in the lane which runs along the south side of them.

The bed of pebbles exposed in the gravel-pit just described runs through beneath the road which leads up the west side of the field in which it is situated towards the southern boundary of Bearwood Park, and is seen again in the wood which covers the slope of Coomb Hill behind Barkham Vicarage, where it forms a rude terrace, numerous flint pebbles appearing in the sides of the ditch, and even here and there among the forest-litter. In this direction it has been proved recently by a trial shaft sunk in the nose of the hill at a spot about 260 feet above O.D. In this hole some 6 feet of buff-yellow loamy sand is at present exposed in a fresh section, which no unprejudiced observer who knows the stratigraphy of the Bagshots of this district could, I think, hesitate to refer to the Upper Bagshot. On following the 250 foot contour-line through the wood, the frequency of the occurrence of pebbles shows the extension of the deposit in that direction. There is no exposure that I have been able to find in Bearwood Park, as the same contour-line is followed towards Bearwood Lake; and as the line is followed towards the house, everything is covered up with ornamental shrubberies and gardens. The model gravel-walks through these are, however, little else than artificially reconstructed "pebble-beds."

At rather less than half a mile to the south-east of the house, an excavation for a reservoir was made a few years ago. I saw it when just dug, in company with my former pupil, Mr. Norman Walter, and was fairly puzzled at the time, from the extraordinary resemblance of the sands exposed to those in our railway-cutting at

[1] Bed No. 4 of my section, Q.J.G.S. April, 1885.

Wellington College Station. The depth of the pit is 9 feet, and all round the sloping sides the pebble-bed comes out in a most unmistakable manner below a surface capping of Drift about 2 feet thick. The pebble-bed itself is from 1 to 2 feet in thickness; its altitude is, within a few feet, that of the bed in Barkham Pit; the pebbles are embedded in sand, and not so compactly aggregated as they are in the Barkham gravel-pit; but there is no mistaking the character of the bed.

If we return to the Barkham Pit, and follow the 250 feet contour-line eastwards and northwards, we can trace the outcrop by the exposure of the pebbles at the surface. Where the hill-slope is rather steep, they have been carried down the slope a few feet by the wash of heavy rains and the action of melting winter-snows. I traced a broad band of them across a turnip-field in the spring of 1886, on a rather steep slope near Sandy Bottom. Many of the pebbles were of large size (3 and 4 inches in length), and so thickly strewn were they across the field that it was impossible to step between them. As the contour-line is followed northwards (on the east side of the Bagshot Outlier), we come across the pebbles again in ditches and in the spinny to the north-west of the Scotch Farm; and they appear to crop out again at the northern extremity of the outlier, outside the churchyard, which is just on the 250 feet contour-line.

There are not many sections of the sands above the pebble-bed, but a small one occurs in the wood on the northern side of Birtle Heath, where I made a clearance of the steep slope in several places with a spade, and satisfied myself as to the Upper Bagshot character of the sands. A more extensive section is exposed in the sand-pit, to the east of Sandy Bottom, some 20 feet or so above the pebble-bed. On one side of this pit there is a very fresh exposure of sands evenly stratified; but as these are followed round the pit, the stratification disappears suddenly, as if it terminated against an ancient sand-dune. The character of the higher bed in this pit bears a striking resemblance to one on the Wellington College Estate, in the Upper Bagshot, not many feet below the 300 feet contour-line.[1] Crossing over to the west side of Sandy Bottom (in reality a small valley of erosion with much sand-wash from the adjoining hills at the bottom), the Upper Sands are again seen in the road-cutting, above the level of the pebble-bed, and they can be seen along the same road as it skirts the south side of Bearwood Park. On descending the hill into the valley of the Loddon, we come again rather suddenly upon the London Clay of the usual dull bluish-grey colour, as I saw it last summer exposed in a fresh road-side excavation, with pebbles of flint dispersed through it. Lithologically, I am unable to recognize in the loamy bed which occurs in this outlier above the pebble-bed anything but the equivalent of the loamy (sometimes even clayey) bed with which I am very familiar, as it occurs at about the same altitude and above the pebble-bed, in the country about Wellington College, and in other parts of the interior of the main mass of the

[1] I am not sure that they are not in reality, in both cases, parts of a later drift.

Bagshot Sands, where the strongest possible evidence (that of proved superposition) leaves no room for doubt as to its occupying a low horizon in the Upper Bagshot.

The longest of the three spurs mentioned above as projecting to the south of the mass of the outlier terminates in a hill about 240 feet above O.D., just to the east of Manor Farm, and rather more than a quarter of a mile to the north of Barkham Church. This hill is of London Clay uncovered by drift on its slopes, and capped by a mass of pebbles and sand of the same nature as that in the Barkham pit. The pebbles were dug here in quantity for some time for road material. The pit is now ploughed over, but the enormous number of well-rounded pebbles seen in the ploughed surface at the top of the hill bears testimony to the nature of this hill-cap, though, not having seen the pit open, I am unable to say whether the cap contained the pebble-bed *in situ*, or consisted of a mass of re-constructed materials.

There are some very ancient gravel-pits about half a mile nearly south-west of the Scotch Farm, where the nature of the drift which caps the outlier can be studied; and in the open field close by there is an open gravel-pit on the crest of the hill, remarkable for the number of Sarsen-stones which occur in the sandy gravel, and for the huge size of some of them; but of the Sarsens I hope to have something to say in a future communication, in addition to what I have already written.[1]

One or two remarks are suggested by this Bagshot outlier at Bearwood.

1. The pebble-bed occurring here so remarkably well developed (as has been shown above) in such a way as to leave no possible room for doubt of its Bagshot age, *at the same altitude* as the pebble-bed at the base of the Upper Bagshot in the more central parts of the Bagshot area, we can hardly avoid assigning it to the same horizon. Though there is no fossil-evidence to bring forward in support of this view, it must be borne in mind that it is only from a few sections in the Upper Bagshot that fossils have been recorded, and such as have been found are nothing more than mere ferruginous casts. There is no dip to the south or east in this pebble-bed.

2. If, on the strength of the pretty strong physical evidence cited above, we are led to assign the outlier at Bearwood to the horizon to which it is assigned in this paper (and I see no valid argument against so doing), then we have here a clear case of Upper Bagshot Sands resting directly upon the London Clay; a phenomenon which can only be explained by the former overlap of the Upper members of the series.[2]

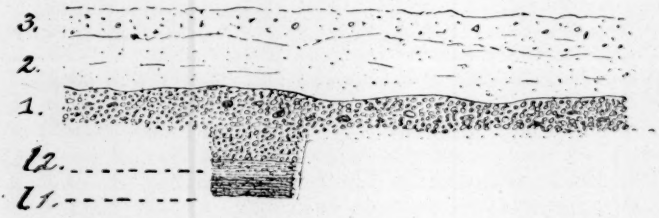
[1] See Proc. Geol. Assoc. vol. viii. pp. 153–160.

[2] A very similar case of a massive pebble-bed *at the base of the Bracklesham Series*, and resting upon London Clay, has been recently mentioned in a letter to the author by Mr Whitaker, as occurring in the Hampshire Basin. No authenticated instance of a bed of pebbles in undoubted Lower Bagshot Sands has yet been recorded in this western part of the London Basin, while those in Essex may for very good reasons be assigned to a higher horizon. (See Whitaker, Geol. of London, p. 52.)

3. There is a remarkable coincidence in the altitudes of the Bagshot Pebble-bed at Bearwood and of the Pebble-bed at Easthampstead Church and at Bracknell with a similar relation of the pebbles to the sands;[1] and I regard the beds of all these three localities as occupying the same horizon and consisting of detritus from older strata accumulated along the northern London Clay shore of the tidal estuary, which covered over the earlier delta-deposits of the Middle and Lower Bagshot, in which the old sand-dunes were for the most part levelled down, while the Upper Bagshot Sands accumulated as we now find them.

Section (East and West) in Barkham Gravel-pit, Bearwood, Berks.

[Massive bed of flint pebbles underlying Bagshot Sands.]



	feet.
3. Reconstructed material of bed 2 with a few pebbles and flints as in the ordinary angular Drift	1
2. Strong ferruginous loamy sand without very pronounced bedding (Bagshot Sand)	2
1. Bed of well-rolled flints, completely rounded, densely packed in a grey-green sand in the upper portion, in a brown loamy sand below. Thickness proved in the excavation	5
l 2. Light-grey clay, slightly laminated	1
l 1. Puce-coloured clay extremely tenacious and plastic	1
	—10

The clay *l* 2 appears to be a decolorized portion of *l* 1, somewhat reconstructed. It is difficult to say if this is original London clay. Both these clays can be matched exactly by well defined clay-beds in the Wick Hill Section (Finchampstead), only three miles distant, which are high up in the Middle Bagshot; also by a clay (at Woodhay) of the Middle Division (Bristow, Mem. Geol. Survey, vol. iv. p. 330), for specimens of which I am indebted to F. J. Bennett, Esq., F.G.S.

VII.—Supplementary Note on *Euphoberia ferox*, Salter.

By Henry Woodward, LL.D., F.R.S., F.G.S.
British Museum (Natural History).

WHEN I noticed this species in the January Number of the Geological Magazine (pp. 1–10, Plate I.), I had not prepared a figure of the original specimen from the Hope Collection at Oxford, which had been kindly lent me by Prof. J. O. Westwood for that purpose.

[1] See Q. J. G. S. August, 1885, and Proc. Geol. Assoc. vol. ix. p. 223. Since the statements here referred to have been published, they have been called in question by the authors of a paper in the Quarterly Journal. The authors of that paper, from insufficiency of observation, have misunderstood the Easthampstead section, and have mistaken a mass of Quaternary drift at the surface for the pebble-bed which I described as occurring at a horizon some 20 feet lower!

Having since obtained a careful drawing, I think it may be desirable to place the earlier figure of this specimen beside the later figure, in order to show how Mr. Scudder was misled by the former, and that in fact (as may be seen by comparing the woodcut Fig. 2 below, with the drawings of other examples given on Plate I.) there

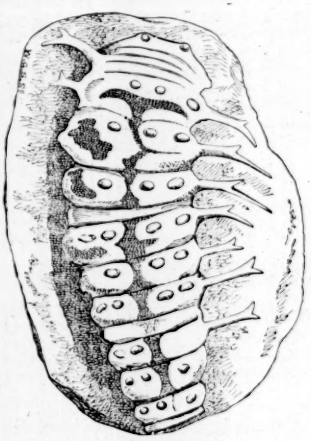


Fig. 1.

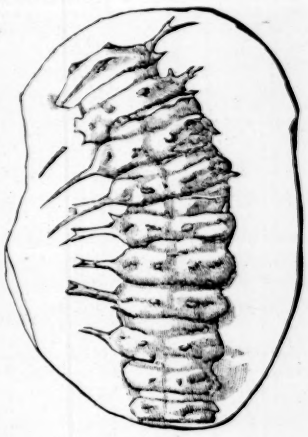


Fig. 2.

Euphoberia ferox, Salter, Coal-measures, Coalbrook-dale ("Hope Collection").

Fig. 1.—Rough copy of original figure in "Brodie's Fossil Insects" (1845, pl. i. fig. 11).

Fig. 2.—The same specimen re-drawn to show that there are only two pairs of spines to each segment.

can be no reason for separating this specimen from its congeners, with which it agrees in every particular.

The lateral spines are bifid, there are two submedian spines, broken off as usual; the supposed third pair of spines on each somite, one on either side above the pair of lateral branched spines, are (as already pointed out on p. 2 *op. cit.*) only *depressions* in the tergum near the base of these lateral spines. This led to the error of attributing the Oxford specimen to the genus *Acantherpestes*, to which it certainly does not belong.

NOTICES OF MEMOIRS.

I.—On the Classification of the Caroniferous Limestone Series; Northumbrian Type. By Hugh Miller, F.R.S.E., F.G.S.[1]

IT is now twenty years since the late George Tate, of Alnwick, published a completed classification for the Carboniferous Limestone Series of North Northumberland. For more than half that period it has been set aside as of merely local value. It will be the endeavour of this paper to restore it to its true place.

[1] Read before British Association, Birmingham, in Section C (Geology).

Tate's classification may be summarized as in the following table :—

CARBONIFEROUS LIMESTONE SERIES OF NORTH NORTHUMBERLAND: TATE'S CLASSIFICATION, 1856-1868.

[References :—G. Tate, History of Berwickshire, Naturalists' Club, 1856, p. 219; *Ibid.* vol. v. 1866-7, pp. 283, 357; Hist. of Alnwick, 1866, p. 444; Tyneside Transactions, vol. ii. 1868, p. 6.]

Upper or Calcareous group:—*From the base of the Millstone Grit to the Dun Limestone*—"*the lowest limestone of any value.*" Good workable limestones, interstratified among alternations of sandstone, shale, and coal; large numbers of marine organisms connected with the calcareous strata. Thickness, about 1700 feet.

Lower or Carbonaceous group:—*From the base of the Dun Limestone to the top of the Tuedian group.* Marked by the number, thickness, and quality of its coal-seams; limestones thin and generally impure; marine organisms in fewer numbers. Thickness, 900 feet.

Tuedian Groups:—*Beds intermediate between the Productal and Encrinital limestones and the Upper Old Red Sandstone.* Distinguished by coloured shales, by thin, argillaceous and cherty or magnesian limestone, and by the rarity of of Encrinites and Brachiopoda; some Stigmarian layers, but no beds of coal. Thickness, about 1000 feet. In one of his papers Tate distinguishes an upper group of "Tuedian grits."

[*Upper Old Red Sandstone.* Local conglomerates, "more connected with the Carboniferous than with the Devonian." No *Stigmaria.*]

The southern part of Northumberland Tate seems to have visited only very occasionally; but from his small map of the county, in which he uses three colours for his three divisions throughout (Tyneside Transactions, vol. ii.), and from his treatise upon the geology of the Roman Wall (Bruce's Roman Wall, 4th edition), it is evident that his careful eye detected nothing to conflict with his classification. Mr. Tate died in 1873.

In 1875, Tate's classification of the upper divisions of the series was set aside by Professor Lebour in favour of an arrangement more "natural and convenient." Professor Lebour abolished the distinction between the *Calcareous* and *Carbonaceous* groups, and threw them together—along with some of the Tuedian grits—into a single large series, to which he applied the term *Bernician.* It is based on the assumption that Tate's two divisions either do not exist in nature or do not persist throughout the county.

CARBONIFEROUS LIMESTONE SERIES IN NORTHUMBERLAND: LEBOUR'S CLASSIFICATION, 1875-1886.

[References :—G. A. Lebour, "On the Larger Divisions of the Carboniferous Rocks in Northumberland," Trans. N. of England Min. Inst. 1876; "On the terms Bernician and Tuedian," GEOL. MAG. 1877, p. 19; "Outlines of the Geology of Northumberland," Newcastle, 1878; "Sketch of the Geology of Northumberland," Geologists' Association, 1886.]

Bernician . . . . . A large group—which "cannot be divided in any natural manner"—of limestones, grits and sandstones, shales, and coals; lower limit, "a variable one," not keeping to any one horizon; thickness, in North Northumberland, 2600 feet (after Tate); in Mid Northumberland, a maximum of "at least 8000 feet"; in South Northumberland, 2500 feet (after Westgarth Foster).

Tuedian . . . . . As in Tate's classification, but without definition at its upper limit.

Basement Conglomerates Local.

It has never been contended, the author believes, that Tate's prior classification is not applicable to North Northumberland. It is now, as the result of the labours of the Geological Survey shows, found to

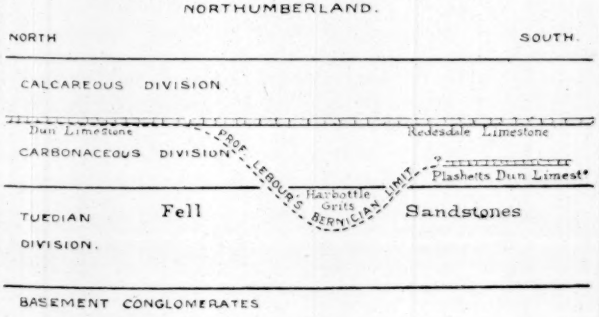
be equally applicable to South Northumberland, and to the whole of what deserves to be distinguished as the *Northumbrian Type* of the Carboniferous Limestone series, in contrast with the Yorkshire type and Scottish type. It is amplified in some not very important details, as set forth in the following table :—

CARBONIFEROUS LIMESTONE SERIES—NORTHUMBRIAN TYPE (Northumberland, East Cumberland, and Liddisdale).

[Reference :—H. Miller, Article "Northumberland," Encyclopædia Britannica, 9th edition.]

		Feet
Upper Limestone Series.	*Fellton or Upper Calcareous Division :—From the Millstone Grit to the zone of the Great Limestone.* Sandstones and shales; one or more beds of marine limestone, including the Felltop Limestone; some coals	350—1200
	Calcareous Division :—From the Great Limestone to the bottom of the Dun or Redesdale Limestone. Many beds of good marine limestone; sandstones and shales; coals	1300—2500
Lower Limestone Series.	*Carbonaceous Division (Scremerston Beds of North Northumberland) :—From the Dun or Redesdale Limestone to Tate's "Tuedian Grits."* Strata prevalently carbonaceous; limestones chiefly thin, many of them containing vegetable matter; coals	800—2500
	Tuedian Division or Tweed Beds :—Upper Tuedian or Fell Sandstone Group, the "Tuedian Grits" of Tate :—From the Carbonaceous Group to the Cement-Limestones. Great belt of massive grits (Tweedmouth, Chillingham, the Simonside and Harbottle Hills, the Peel and Bewcastle Fells). Shales greenish and reddish as well as carbonaceous-grey; coals rare, thin, or absent . .	500—1600
	Lower Tuedian or Cement-Limestone Group :—From the base of the Grits downwards. Cement-stone bands passing (Rothbury, Bewcastle) into limestones; coals very rare; generally some coloration of the shales and sandstones	530—1500
	Basement Conglomerates (Upper Old Red Sandstone); local .	0— 500

The relation borne to the lines of this extended classification by Prof. Lebour's Bernician limit, so far as he has hesitatingly defined it by horizons,[1] is shown in the following diagram :—



[1] "To the north of Berwick, the lowest accepted Bernician limestone is the Dun limestone, well known throughout the northern part of Northumberland, but only with great reserve to be correlated with a bed of the same name in the Upper North Tyne district (the Plashetts Dun Limestone of the diagram). This is the limestone

Tate's admirable classification presents us with well-defined types, generally recognizable almost at a glance by the practised eye, and bounded by lines as good probably as from the complications of the structure (faults, obscurities, etc.) could be expected. His names, if not high-sounding, are at least sufficiently expressive.

II.—The Carboniferous Limestone of North Flintshire. By G. H. Morton, F.G.S.

(Abstract of Paper read before the British Association, Birmingham, September, 1886.)

IN the year 1870 I described before the Association the subdivisions into which the Carboniferous Limestone of North Wales is naturally divided by clear lithological characters, and in 1877 more fully described the subdivisions of the formation as they occur in the Eglwyseg ridge, near Llangollen. Since then the whole of Flintshire has been examined, and the original classification found to extend to the sea-coast at the north of the county. Although the subdivisions are not piled up, one over the other, in a precipitous outcrop, the succession is as clearly shown between Prestatyn and Meliden as at Llanymynech and Llangollen, and the uniform character of each subdivision along the intervening 44 miles of country is remarkable.

The following four subdivisions of the Carboniferous Limestone are all well exposed in a fine mural section 3¼ miles in length, from Castell Prestatyn on the north to the end of Moel Hiraddug on the south, and occur in the following descending order:—

Upper Black Limestone—a black, fine-grained, thin-bedded limestone, containing very few fossils, but including *Posidonomya Becheri* and the remains of many plants. Thickness, 200 feet.

Upper Grey Limestone—a dark grey, thin-bedded limestone, with thin seams of interstratified shale, containing numerous fossils, including *Productus giganteus* and Corals. Thickness, 500 feet.

Middle White Limestone—a white or light grey, thick-bedded limestone, containing very few fossils. Thickness, 600 feet.

Lower Brown Limestone—a brown or dark grey, irregularly-bedded limestone, containing few fossils, but with interstratified shales at the base of the subdivision, which contain the remains of Plants. Thickness, 400 feet.

The total thickness of these four subdivisions, forming the Carboniferous Limestone of the North of Flintshire, is 1700 feet, which is much greater than anywhere else in North Wales.

Although the line of the section is nearly N. and S., the average dip of the strata is about 14° to the E.N.E. at Coed-yr-Esgob, N.W. at

which crops out for some miles along the coast at Lamberton . . . But in the Upper Coquet district (Mid-Northumberland), where the Tuedians are extremely well developed, no such limestone can (could) be traced, and the Harbottle Grits are so thoroughly Bernician in facies, and so well divided stratigraphically from the Tuedians, that *there* the base of this great sandstone series forms quite the most convenient boundary-line. Now there is little doubt that the horizon of the Lamberton or Dun Limestone is *above* the Harbottle Grits, so that the merely expedient and artificial character of the boundaries thus arrived at is shown at once. The truth is that no line should be drawn at all except as the merest matter of convenience."—Lebour, Outlines of the Geology of Northumberland, p. 44. In the diagram it is of course a matter of convenience that this confessedly artificial limit should be represented by a dotted line.

Bryniau, and N.E.N. at Moel Hiraddug, so that it is greater than it appears to be in the section. The highest subdivision, the Upper Black Limestone, occurs at the north end, and the Upper Grey Limestone crops out from under it, and extends to Nant-yr-ogof, where there is a considerable fault, which brings up the top of the Lower Brown and the base of the Middle White Limestone. From the fault the Middle White extends three-quarters of a mile, when the Lower Brown Limestone crops out, continues some distance, and forms the conspicuous hill, Moel Hiraddug, on the top of which the lower beds of the Middle White Limestone are again exposed.

Along the west and parallel with the section there are two great faults, known as the Prestatyn fault and the Vale of Clwyd fault, and on the western side of the former a bare limestone hill, Graig-fawr, rises to an elevation of 500 feet, and presents a grand exposure of the Middle White Limestone, which is 600 feet in thickness. Numerous fossils occur at the north end of Graig-fawr, and a greater number has been obtained there than from the Middle White Limestone anywhere else.

On the west of the Carboniferous Limestone shown along the line of section several faults, including the two already referred to, have thrown down the limestone beneath the level of the sea, and the Lower Coal-measures have been proved to occur at Meliden and Dyserth, beneath a deep covering of drift. In one of the recent "Memoirs of the Geological Survey," by Mr. A. Strahan, M.A., F.G.S., a full description of the Geology—*Explanation of Quarter-sheet* 79 *N.W.*—will be found, with all the details of the drift and underlying strata.

III.—A Sketch of the History of the Rivers and Denudation of West Kent, etc. By F. C. J. Spurrell, F.G.S. 8vo. Greenwich, 1886. [Reprinted from the Report of the West Kent Natural History Society, 1886.]

THE author commences with some remarks on the "plane of marine denudation" which was produced over the Wealden area before the present features were carved out by subaërial forces. He observes that nowhere over the Wealden rocks is there to be found any deposit belonging to that old marine age; but it is quite possible that the Pliocene deposits of Lenham, etc., may be relics of the period. He then refers to the denudation by rain and rivers, and the breaching of the Chalk Downs, and states that "On the crest of the Downs there may be found in some places relics of the rocks from the Weald, Gault Clay, Chert, Greensand, Sand and Limestone, etc., lying on the Chalk, not in the condition of river gravel, but of patches of the old beach." The gravel of Shooter's Hill is, in his opinion, largely composed of the wreck of Bagshot Beds, and there are many similar outliers of pebbly gravel. These beds occur, as a rule, at a higher level than the Thames Valley gravels, and they may be distinguished from them by the absence of the erratic pebbles and fossils of northern origin (derived from Glacial Drifts), that occur in the newer deposits. These Thames Valley gravels, in Mr. Spurrell's opinion, lie below the 200 feet contour-line, the highest elevation being at Wimbledon, 190 feet.

Referring to the Flint Implements found at different levels over the whole district, he observes that he is unable to draw a sharp line of demarcation between Palæolithic and Neolithic forms.

Turning his attention to the subject of superficial deposits, he devotes the second part of his paper to the Warp and Trail, described by Joshua Trimmer, and the Rev. O. Fisher (see GEOL. MAG. 1867, p. 193); and this subject is illustrated with a number of sections showing the superficial disturbances affecting the Trail. To the folds he applies the name "Underplight," reserving the name Trail for the material filling the troughs and hollows. He believes that the folds or Underplight "may have resulted from the heavy pressure of a superincumbent mass of snow on a soil in a condition capable of yielding, and frequently repeated." No doubt many instances of Trail may in this way have been disturbed, for the Trail after all is generally but the relic of a more extensive gravelly accumulation which has been for the most part denuded. Surface disturbances of similar character are produced in strata over which the Chalky Boulder Clay has been accumulated, and are referable to the agent (probably land-ice) which formed it. Mr. J. G. Goodchild also has drawn attention to many instances of surface disturbance in Kent (to whose paper, by-the-bye, no allusion is made by Mr. Spurrell), and he has suggested that they were probably produced in Glacial times (Proc. Geol. Assoc. vol. ix. p. 151).

REVIEWS.

I.—MIKROSKOPISCHE PHYSIOGRAPHIE DER MASSIGEN GESTEINE. Von H. ROSENBUSCH. 1 Abtheilung. Zweite gänzlich umgearbeitete Auflage. (Stuttgart, 1886.) [Pp. 416.]

MICROSCOPIC PHYSIOGRAPHY OF THE MASSIVE ROCKS. By H. ROSENBUSCH. Part I. Second edition, completely revised.

THE appearance of a second edition of Professor Rosenbusch's well-known treatise on the microscopical study of the igneous rocks will be hailed with satisfaction by all workers in petrology. The present instalment is the first part only: the remaining portion, with the plates for the whole work, is to be expected next Easter.

On the publication of a new edition of a standard work, the reader naturally wishes to note what alterations and additions have been made to the former text; but the present edition is so completely re-written as to be practically a new work, and important differences of principle, as well as method, render futile any detailed comparison with the original. The chief features of the author's new treatment of the subject are the prominence given to structure and geological mode of occurrence, the subordination to them of purely mineralogical characters as a criterion of classification, and the abandonment, to a great extent, of geological age, or assumed age, as an essential character of igneous rocks. It is true that the division into older (Pre-Tertiary) and newer (Post-Cretaceous) groups is retained among the volcanic rocks: but the only reasons assigned for this artificial

classification are those depending on the history of the science, and the practical difficulty of referring the older rocks definitely to a volcanic origin, owing to the "ephemeral" nature of volcanic formations and the easy removal of the tuffs by denuding agencies (pp. 6 and 346). These reasons will perhaps not appear conclusive to most English geologists.

At the outset the author divides igneous rocks, according to their mode of occurrence, into plutonic (*Tiefengesteine*), volcanic (*Ergussgesteine*), and a group of intermediate nature occurring characteristically in the form of dykes (*Ganggesteine*). The volcanic class includes the tuffs as well as the lavas.

The structure of igneous rocks is dealt with on the lines indicated in the author's valuable paper in the *Neues Jahrbuch* (1882, vol. ii. p. 1), in which he divides the rock-forming minerals into four groups, and lays down the important law that in granular igneous rocks of the normal type the minerals have consolidated in a definite order, that of "decreasing basicity." The term *granular* is restricted to those holocrystalline rocks in which each constituent mineral is entirely of one generation, thus indicating a steady change of chemical and physical conditions throughout the process of consolidation. This is opposed to the *porphyritic* structure, where some of the minerals recur in a second generation, giving evidence of two distinct periods in the formation of the rock. The form of an individual mineral in a rock may either be due to its own mode of crystallization (*idiomorphic*), or dependent on causes other than the molecular forces proper to the mineral (*allotriomorphic*). The normal plutonic rocks are characterized by a structure in which idiomorphic constituents occur only in small proportion (*hypidiomorphic*): this is contrasted with the *panidiomorphic* structure of a certain type of dyke-rocks, in which nearly all the component minerals exhibit more or less crystalline forms.

The plutonic rocks are divided by the author, according to their mineralogical constitution, into eight families. Here the chief new features noticeable are the division of the felspars into alkali-felspars, and lime-soda-felspars, superseding to some extent the old distinction of orthoclase and plagioclase, and the introduction of a family of plagioclase-nepheline-rocks (styled *Theralites*) to balance the elæolite-syenites. The diabases are placed in the plutonic class, though with an admission of their intermediate nature (p. 173). The headline "The Tuffs of the Diabase-rocks" under the class "*Tiefengesteine*" certainly has an anomalous appearance.

As in the old edition, each family is fully treated under several heads—mineralogical composition, classification, structure, and the phenomena of metamorphism produced or suffered by the rocks. There is much new matter, especially with reference to the local variations (*Faciesbildungen*) of rock-masses, the effects of contact and mechanical metamorphism, and the secondary alterations of rock-forming minerals. The bibliographical lists are much enlarged, and the matter throughout is brought well up to date.

The author next treats of the dyke-rocks, among which are found

mineralogical representatives of four of the above eight families—the granites, syenites, elæolite-syenites, and diorites. They exhibit three types of structure: the *granitic*, met with only in the most acidic rocks (Aplite, which is thus removed from the granites); the *granite-porphyritic*, divided mineralogically into granite-porphyry, syenite-porphyry, elæolite-syenite-porphyry, and diorite-porphyrite; and the *lamprophyric*, including syenitic and dioritic families only. The lamprophyres, as that name is used by the author, are either panidiomorphic-granular or holocrystalline-porphyritic in structure. The syenitic lamprophyres comprise Minette and Vosgesite, the latter name being given to those members which contain hornblende or augite in place of biotite; similarly the dioritic family divides into Kersantite and Camptonite.

The characteristic structure of the volcanic rocks is the *porphyritic*, which is classified under various types according to the nature of the ground-mass. The palæo-volcanic rocks are ranged under five families: quartz-porphyries, quartzless-porphyries, porphyrites, augite-porphyrites and melaphyres, and picrite-porphyrites; of which only the first is treated in the part of the work already issued. The discussion of the essential nature of the ground-mass in the quartz-porphyries and the section devoted to the classification and structure of these rocks have been rendered fuller, but little is said on the subject of secondary devitrification. The artificiality of the separation of palæo- and neo-volcanic rocks is sometimes apparent, as for instance in the description of the Arran pitchstones on p. 407.

Professor Rosenbusch's treatise seems to be a real step towards a true natural classification of rocks, and perhaps we may even be sanguine enough to hope that it will afford a basis for a uniform system of nomenclature in petrological writings. A. H.

II.—M. Dollo's Notes on the Dinosaurian Fauna of Bernissart.

(*Continued from p.* 87.)

The hind limbs next claim attention. Having insisted on the avian form of the femur, and its divergence from birds in being relatively longer as compared with the tibia, M. Dollo goes on to argue that, whereas the femur is horizontal in birds, its length implies a more inclined or mammalian position in these Dinosaurs. We are unable to appreciate the force of the argument, which might have some weight if the animal were an ordinary quadruped. But, in the first place, the Kangaroo, an animal not entirely beyond comparison in its proportions, carries the femur at rest in a nearly horizontal position; and, secondly, by giving the femur this highly inclined position, M. Dollo raises the extremity of the ischium and the chevron bones of the caudal vertebræ off the ground to a level with the distal extremity of the tibia. Now, when the skeleton of such an animal as *Iguanodon Bernissartensis* is examined, the tail, unlike the tail of a Kangaroo, is seen to have consisted of dense muscular substance like the tail of a Crocodile, of enormous weight, extending from the extremities of the chevron bones to the

ities of the neural spines. Just as the lifting of this weight he ground would be a purposeless expenditure of strength he animal was at rest, so I think the analogy of the Crocodile, is not quite incomparable in caudal structure, may be appealed evidence that the tail was carried in a lower position than llo gives it. To bring this result about we must flex the ore at the knee, so as to make the femur more nearly hori- and incline the tibia further forward, which would give a easy, and I think more natural position, than the expectant e into which the animals are at present hoisted. The bones posterior extremity are well described. Evidence is given he outer distal condyle of the femur articulates with the l crest of the tibia, and that the fibula, which is shorter than ia, has its distal extremity brought in front of the tibia, in the dicated by Marsh in the *Archæopteryx*, so as to articulate with imal facet of the calcaneum, a portion of which is applied to ia. The author does not clearly distinguish in his description n the two types referred to *Iguanodon*; but since he states that o bones of the proximal series of the tarsus articulate with each the description may well refer to *I. Bernissartensis*, in which ow, from other evidence, that this condition obtains. The tarsal row, not hitherto described in *Iguanodon*, is said to of three bones. A thin bone articulates proximally with the lus, and distally with the first and second metatarsals; a bone, rather stouter, lies between the astragalus and the metatarsal; and the third, of intermediate size, rests on rth metatarsal, and articulates with the calcaneum. This ow is noticed as being quite as avian in general character as oximal row. The author describes the metatarsus, which has een well known in *Iguanodon Mantelli*. He points out that ond to fourth metatarsals are the three usually developed in nd that the bones are placed with regard to each other as in so that the middle metatarsal is slightly displaced forward , and backward proximally. The number of phalanges onds with the number in lacertilians and birds, being 3-4-5. lly, M. Dollo adopts the dictum of Huxley that if the res between the ilium and the digits of a young fowl are d to augment to the bulk of a Dinosaur, and then to be and fossilized, there would be no characters to separate the onding parts from those of these gigantic reptiles. There oubt much truth in this generalization, which we should be d to accept in principle so far as *Iguanodon* is concerned. If it orth while for M. Dollo to pursue his line of argument concern- avian characteristics of the Dinosaurian pelvis and hind limb, lly to the exclusion of all other resemblances, the comparisons erive their importance from being steps in a chain of proof, hat Dinosaurs have acquired their avian characteristics in ience of the muscular development and functions of the r extremities being avian, in types like *Iguanodon*, or else that enera, in which avian characters culminate, are ancestors of

birds. M. Dollo has already elected to dismiss for the present both of these questions, but the subject is one which must eventually be faced, and I venture to urge that the functional development of avian characters is the safest basis of interpretation; first, because functional conditions are the primary directing cause of structural variations; and, secondly, because the modifications of structure in any Dinosaur which would be necessary to convert it into a bird, are not less considerable than would be required to convert a Crocodile into a Dinosaur. If Dinosaurs and Birds are supposed to descend from an ancient common stock, then the functional evolution of some avian characters in certain families of Dinosaurs becomes more intelligible. M. Dollo's chief inference, however, from the avian resemblances is, that the *Iguanodon* also must consequently be inferred to have been a biped. He quotes Sir Richard Owen to show that the mere difference in size between the fore and hind limbs would not establish this conclusion, since the difference, as marked in the Crocodile and in *Iguana*, is relatively almost the same as in *Iguanodon Mantelli*. The proof of the biped condition is made to rest upon the greatly reduced size of the anterior extremities, the difference in number of digits on the anterior and posterior limbs (both of which characters are common to the Crocodile); and, thirdly, divergences of structure which show a different physiological use for these members. Here a good deal is assumed. The presence in *Iguanodon* of a powerful offensive spine on the inner anterior digit, which has no parallel in the hind limb, is surely a doubtful argument that the animal was a biped. The argument would have been much stronger if the author had been content to show that the weight of the tail would necessitate the trunk being thrown into a forward position, so that the body could only have been carried when balanced on the pelvic axis. The author goes on to contest Sir Richard Owen's arguments against the upright position, in the course of which he states that the neck is relatively long, containing ten or twelve vertebræ, while in the dorso-lumbar region there are sixteen or eighteen. The opisthocœlous articulation of the centrum, and the nature of the zygapophyses give great mobility to the neck; and, although the number of vertebræ in the sacrum is smaller than that in birds, yet this number may be apparently reduced, since the number of sacral vertebræ in *Archæopteryx* is probably fewer than in *Iguanodon Bernissartensis*. M. Dollo remarks that the position of the occipital condyle is interesting as having an intermediate position between the horizontal arrangement of quadruped reptiles and the condition in birds, in which the head is carried at right angles to the neck. The foot-prints which have been attributed to *Iguanodon Mantelli* are discussed, with the result that the author finds evidence of no other known Wealden Dinosaur which could have produced these tridactyle impressions, while the bones of the three digits are superimposed successfully on the natural cast; and hence it follows that the animal walked as a biped, without leaving any impression of its tail upon the shore. The author agrees with Sir Richard Owen that the resemblance of the tail to that of a Crocodile, and the develop-

ment of the lateral trochanter to the femur, may be taken as evidence of aquatic habits for these Dinosaurs, which are supposed to have frequented marshes, and to have been, like Crocodiles, more frequently in water than on land. And on this view the bipedal position is regarded as a protective adaptive modification, by which the animal was enabled to discover carnivorous enemies and encounter them with advantage.

At this point M. Dollo diverges into an interesting note on the presence of the third trochanter in birds, and on its function. Describing the femur of the Crocodile and bird, it is stated that the femur of *Iguanodon* is constructed upon the avian plan, and this view is supported by a dissection of the Wild Duck, in which, as in the Bernicle Goose, and Swan, a faint indication of the lateral Dinosaurian trochanter is found. The author shows that the distal portion of this ridge in birds gives attachment to a small caudo-femoral muscle (which, however, was large in some Dinosaurs, such as *Orthomerus Dolloi*), and to a large proximal ischio-femoral muscle. Accordingly, the trochanter which occupies the middle of the inner side of the shaft in a Dinosaur is attributed to these muscles. It is probable that this explanation may be substantially correct; only the tail of a Dinosaur is so essentially the tail of a Crocodilian, that we must suppose its muscular structure to have resembled that of the Crocodile's tail, in which the transverse division of the caudal muscular masses is as well marked as in other cold-blooded Vertebrata. I would especially urge that, even if this homology of the lateral trochanter is beyond question, it does not in itself quite establish the view that the *Iguanodon* femur is built on the bird type, or used under conditions like those of a bird's femur.

In common with many other naturalists, M. Dollo prefers to name the lateral trochanter the fourth trochanter, reserving the name third trochanter for the process usually so named in mammals.

The fourth note is devoted to the skull and axial skeleton. Commencing with the mandible, it is shown that the coronoid process occupies an unusually backward position, and that the teeth extend behind it, as far as the middle of the temporal fosse. In addition to the dentary, coronoid, and articular bones, which are seen on both sides of the jaw, the angular, surangular, and splenial bones are visible only on the inner side. Anteriorly, in front of the dentary bone, forming a horse-shoe-shaped extremity to the jaw, is a bone which the author names pre-symphysial, and which Mr. Hulke has named pre-dentary. It is convex externally, concave internally, and its upper border, relatively thin, rises into bony processes like denticles. This ossification appears to characterize the group of Dinosaurs allied to *Iguanodon*, and probably gave a cutting surface to the front of the jaw, comparable to that seen in Chelonians. The author would compare it to a representative of the two pieces which unite the rami of the mandible of anourous Batrachians, which Professor Albrecht terms inferior intermaxillaries; and as these elements carry teeth in *Amphignathodon Guentheri*, the author believes that a like toothed condition is developed in *Hypsilophodon*. Detailed

descriptions follow of the other elements of the jaw, from which it appears that the coronoid process is formed by the dentary, coronoid, and articular bones. As a whole, the lower jaw perhaps has most correspondence with *Hatteria*.

The skull in *Iguanodon Bernissartensis* is 65 centimetres long, 25 centimetres wide, and including the mandible, 35 centimetres high. The head is described as having a transversely compressed lacertilian aspect, with the external narines divided, sub-terminal and lateral; with the orbits lateral, of moderate size, without sclerotic ossifications; the temporal fossa are limited by superior and inferior arcades. The cerebral cavity is completely ossified. Teeth are limited to the maxillary bone. The description treats of the roof of the skull, and its cavities. I cannot give here all the details conveyed in the description and figures; but there are two pre-maxillaries, extending between the nares and forming their anterior and inferior borders. The alveolar margin is edentulous, and no doubt had a horny covering opposed to that of the predentary bone below. It closely resembles the premaxilliary of *Hypsilophodon*, except that the bones in *Hypsilophodon* carry teeth. The maxillary bone is large, uniting anteriorly with the premaxillary, superiorly with the nasal, with a bone termed supra-orbital, as well as with the lachrymal and prefrontal, while posteriorly it unites with the jugal. On the palate it connects with the external pterygoid, and apparently with the palatine. It carries 25 teeth in use. Its resemblances are with the maxillary of *Hatteria* and *Iguana*. It contains towards the lachrymal, a prelachrymal vacuity. The nasal bones are long and well developed, forming the roof of the skull between the orbits and nares. The frontal bones have a great transverse expansion, and are large and flat. They margin the orbit above, and on their lateral border are two bones termed supra-orbital. There is no trace of a median suture to the frontals such as characterizes *Iguanodon Prestwichi*. The prefrontals each carry a supra-orbital, so that they are hidden laterally. The lachrymal is connected with the prefrontal, maxillary, and jugal. The jugal is attached to a special process of the maxillary, which is given off some distance in advance of the termination of the alveolar border. This bone unites with the lachrymal, post-frontal, qudrato-jugal, and maxillary. It is stated that there is a quadrato-jugal, which unites with the quadrate, but in the figure (plate ix. fig. 1) there is no suture to separate the parts of the bone which are lettered respectively jugal and quadrato-jugal. Up to the spring of 1879 I supposed that the quadrato-jugal had no separate existence in Dinosaurs, and so wrote of it; but I learned better in the autumn of 1879, when, by the courtesy of M. de Pauw, I was enabled to draw the details of the parts of the Bernissart skeletons which were then developed. The post-frontal bone has the usual connections with the parietal, frontal, squamosal, and jugal. It divides the orbit from the lateral temporal fosse, and borders the anterior margin of the supra-temporal fosse. The squamosal bone is connected with the post-frontal, the parietal, supra-occipital, parotic, and quadrate bone. These bones, like the parietals, find

considerable resemblance in the living *Hatteria*. They are undivided, and have a somewhat prominent median crest. The form of the brain case appears to correspond with that already described by Mr. Hulke. The quadrate bone is remarkably long and strong, covered proximally by the squamosal bone, like a hat; it sends a process inward to articulate with the pterygoid. Many of the bones of the palate, notably the vomer and palatine, are extremely thin long bones. The pterygoids are thrown back towards the occiput. They are in contact with the ectopterygoids, below the temporal fossa, and closely resemble the pterygoids of *Hatteria*. Regarding the *Hatteria* as a Lizard, the author agrees with Huxley and Hulke that the palate was lacertilian rather than crocodilian. But *Hatteria* is I submit no more a Lizard than a Crocodile. The vertebral column in *Iguanodon Bernissartensis* comprises 85 vertebræ, of which 10 are cervical, 18 dorso-lumbar, 6 sacral, and 51 caudal. In the neck the vertebræ are opisthocœlous, in the back and loins flat at both ends, in the sacrum anchylosed, and in the tail slightly amphicœlous. In the neck all the vertebræ except the atlas carry ribs; one vertebra in succession to the dorsal series is counted as lumbar, having no ribs.

The fifth note states that in *Iguanodon Mantelli* 65 vertebræ are at present known. They comprise 10 cervical, 16 dorsal, 2 lumbar, 5 sacral, while in the tail only 32 vertebræ are preserved. All the cervical vertebræ except the atlas carry ribs. The atlas has the usual reptilian condition. The author then enters into a discussion of the bones named by Marsh post-occipital,[1] identifying them with the pro-atlas of Albrecht.

The author then goes on to show that the form of the skull depends upon the development of the muscles which work the lower jaw. And states that in *Sauropsida* the temporal and masseter muscles are often united. When the temporal is predominant, there is a strong sagittal crest, the coronoid process of the mandible is well developed, the supra-temporal fossæ are large openings; while the pterygoids are thin, parallel to the plane of the skull, and the quadrate process of the pterygoid is not ossified. When the internal pterygoid muscles have a predominant development, there is neither sagittal crest to the skull nor coronoid process to the mandible; the supra-temporal fossa are closed, the pterygoid bones are thick plates, perpendicular to the median plane of the skull; while there is a mandibular fontanelle. The former type is Lacertilian, the latter is Crocodilian. In *Iguanodon* the muscular arrangements were in the main Lacertilian, while in *Ceratosaurus* they were more Crocodilian. Many herbivorous Dinosaurs, however, used in mastication muscles, which are only developed among mammals in the Carnivora; and the *Teleosauria* show in the sagittal crest, large temporal fossa and narrow pterygoids, evidence that the temporal muscles were large and the pterygoid muscles small, or in other words the animals had the reverse development of these muscles to that seen in Crocodilia. In

[1] These bones had long been known in fishes, and were described in the Carp by Mr. Robertson of the Oxford University Museum, and by many other writers.

this matter of the muscles *Iguanodon* and its allies are termed by M. Dollo slightly modified types, while *Ceratosaurus* and *Diplodocus* are more specialized; and just as Professor van Beneden has shown that since Miocene times the form of the skull in *Mystacocete* has undergone a specialization by shortening, so *Diplodocus* presents a similar specialization as compared with *Iguanodon*. Thus, by muscular modification, the primitive terminal narine comes to occupy a more backward position. It would take more space than is here available to discuss these interesting speculations.

On the prelachrymal vacuity M. Dollo observes that, it is small in Dinosaurs which have the pterygoid muscles feeble, and large when they are greatly developed. The pterygoid muscles are inserted in birds on the anterior border of the pre-lachrymal fossa, so that it seems possible that the size of the vacuity may depend upon the volume of the muscle which passes through it.

These papers are but a small fraction of the mass of valuable memoirs which the author has published. Any one who studies them carefully will be impressed by the originality and power of the writer. His method is his own. The memoirs that we have noticed are a landmark in the history of the group to which they relate, greatly adding to our knowledge, and applying the methods of comparative anatomy for the elucidation of Dinosaurian structures in new ways. We trust that the time is not distant when the author may be enabled to issue detailed monographs, like those in which Van Beneden has so well described the Mammalia of the Antwerp Crag; for the development of exact knowledge of all Dinosaurians cannot but be influenced by the data for comparison which such monographs would afford. When this work is done, we may anticipate that stringent comparisons of form and measurement of bones will be made, and that the same canons of determination will be extended to fossils as have already given to the comparative anatomy and zoology of living animals many of the attributes of an exact science.

H. G. Seeley.

III.—Géologie de Jersey. Par Le P. Ch. Noury, S.J. Pp. 173, with coloured map. Price 5*s*. (Paris, Librairie F. Savy; Jersey, Librairie Le Feuvre.)

THIS book is modestly described as intended principally for residents and visitors, but it contains matter that may be useful and interesting to any geologist.

After a notice of previous writers and some general remarks, the author commences with a "Brief Description of the Rocks." He describes the nature and distribution of the many varieties of eruptive rocks, classifying them as granitic, granitoid, porphyry, diabase dykes, mica-trap dykes, and diorite dykes. The granitic rocks are subdivided as granite proper, forming the N.W., S.W., and much of the S.E. corner of the island, and granulite such as that of the Mont-Mado quarries. "Granitoid" rocks include syenite and diorite, the latter occurring in considerable mass on the S.E. shore. Along with the porphyry are described the remarkable

pyromerides (perlitic felstones?), which in one locality named present immense spherules attaining diameters of as much as a foot. "Spherolithes" nearly as large are mentioned as occurring in one of the diabase dykes, but the description points to these being spheroidal weathering. The localities of mica-trap dykes are carefully enumerated.

The sedimentary rocks are said to be chlorite-schist (the first notice of its occurrence in Jersey); felspathic schist or grit, including by far the largest part; metamorphic schist; and conglomerate. The metamorphic schist is divided into "spilites" and "porphyres argileux," the distinction made between these is not very clear. The author seems to regard both as altered forms of the felspathic schists, but alludes to the possibility of the "spilites" being eruptive. The metamorphism he thinks mainly due to the eruption of the porphyries; he does not seem to have considered the idea that they may be ashes belonging to those eruptions. The remarkable conglomerate of the N.E. corner is very fully described.

Next comes a chapter on "Contours and Relief of the Island," in which its physical geology is treated with admirable completeness. The caves and clefts, the giants-kettles, pits, and natural tunnels, are enumerated and explained almost individually: similarly with the inlets, cliffs, and bays. Specially interesting are his descriptions of the Pinacle and the Creux de Vis or Trou du diable. The origin of nearly every valley is discussed, and many valuable remarks are made on the causes which guided and shaped the channels.

In the chapter on the Past of Jersey the author assumes the hypothesis of an original granitic crust on which afterwards the gneisses were deposited in an intensely heated ocean. Sedimentation in a more normal sea laid down the Jersey rocks which he calls schists, and to which he assigns a Cambrian age. (The term schist is not very appropriate to these rocks.) Nothing shows, he says, whether the true granites are prior to them or not; the other eruptive rocks are certainly later, and range from Cambrian or Silurian to Triassic; evidence is to be found in other regions. No sedimentary rock exists between the Cambrians above named and the conglomerate; to this he attributes a Permian age, and he gives good reasons for regarding it as due to sea-wave, not torrent action. A section on Quaternary and modern geology contains a very able discussion of past oscillations of land and sea. After a careful sifting of the evidence, he concludes that since the Roman occupation only subsidence has happened: and that probably Jersey was still joined to Normandy as late as the sixth century. The discussion of this question contains many interesting remarks on dunes and their growth, submerged forests and their mode of origin and destruction, the formation of raised beaches, and other important points in littoral geology. He adduces reasons for thinking that some at least of the "raised beaches" of the Channel Islands are not due to changes of level.

A vein of humour appears here and there: as in the relation of a stonemason's belief that building-stones can be corroded by the moon's rays.

The book is a valuable monograph: the topographical indications are especially full and excellent. It is well printed and furnished with a good coloured map and some sketch-plans. Only a resident could have produced such a work. Jersey is to be congratulated on possessing one both able and willing. E. Hill.

REPORTS AND PROCEEDINGS.

I.—Imperial Geological Institute, Vienna.

September 30th, 1886.—On *Cretaceous Crustacea* of Mount Lebanon, by Herr Dames.

Ranina cretacea, sp. n., near the Eocene form *R. marestiana*; *Penæus septem-spinatus*, sp. n.; *Penæus Libanensis*, Brocchi; *Ibacus præcursor*, n. sp. (a post-abdomen); *Pseudastacus Hakelensis*, O. Fraas, very frequent, generic position not yet clearly ascertained, as also of *Pseudastacus minor*, O. Fraas. *Sculda Syriaca*, sp. n.; *Sculda* is the representative of a peculiar family, the oldest known type of *Stomatopoda*. *Sculda lævis*, Schloth. (=*Squilla Lewisi*, Woodw.), is the type of another family and genus—*Pseudosculda*, Dames. *Pseudosculdidæ* are known to exist in the Upper Cretaceous. *Sculdidæ* in the Upper Cretaceous and Upper Jurassic; and genuine *Squillidae* (*Squilla cretacea*, Schloth.) begin in the Upper Cretaceous, and continue upward to the present time.

Larvæ of crustaceans—Pseuderichthus cretaceus and *Protozoëa Hilgendorfi*, sp. n., are very frequent near Sahel Alma. *Limulus Syriacus*, Woodw., *Loriculina Noetlingi*, Dames, are found at Hakel. The beds of both localities, Sahel Alma and Hakel, although possessing a quite different Ichthyological and Crustacean fauna, appear to be coeval; and, considering the presence of Jurassic and early Tertiary forms, may possibly be of Upper Cretaceous age. The fauna of Hakel, notwithstanding the difference of age, offers striking comparisons with the fauna of the Bavarian Lithographic flagstones. It includes a few Post-Cretaceous types, such as *Ibacus præcursor* and *Ranina cretacea*.

II.—Geological Society of London.

(1).—January 26, 1887.—Professor J. W. Judd, F.R.S., President, in the Chair.—The following communications were read:—

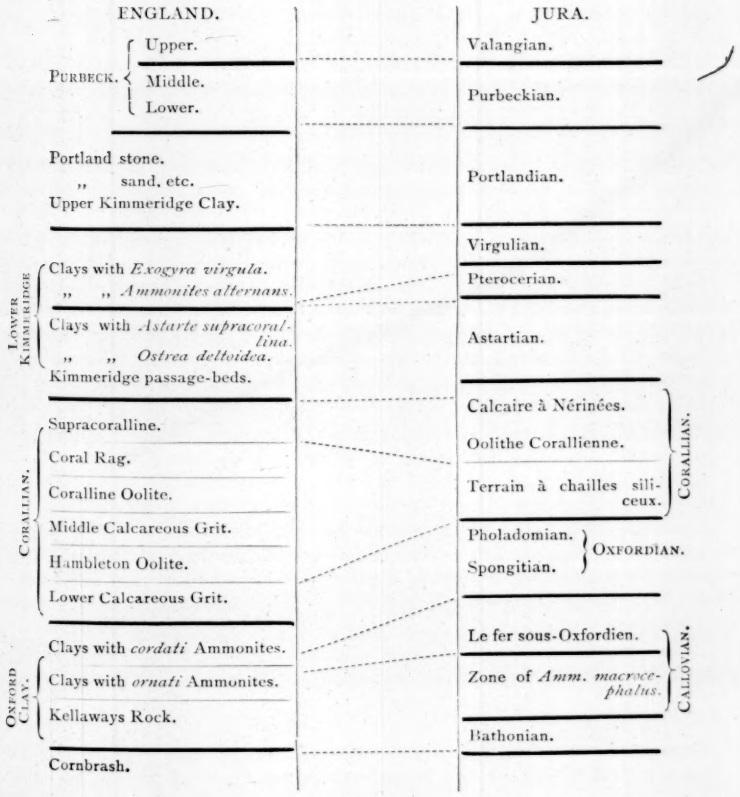
1. "On the Correlation of the Upper Jurassic Rocks of the Jura with those of England." By Thomas Roberts, Esq., M.A., F.G.S.

The author described at length his observations on the rocks of the Jurassic system, from the Callovian to the Purbeckian inclusive, first in the Canton of Berne, and then in the more southerly Cantons of Neuchâtel and Vaud. The sections in the former differed materially from those in the latter: the following stages were observed:—

North District.	South District.
Purbeckian.	Purbeckian.
Portlandian.	Portlandian.
Virgulian.	?

	North District.	South District.	
	Pterocerian.	Pterocerian.	
	Astartian.	Astartian.	
Corallian.	Calcaire à Nérinées.		
	Oolithe Corallienne.		
	Terrain à chailles siliceux.	Corallian.	
Oxfordian.	Terrain à chailles marno-calcaire.	Pholadomian.	Oxfordian.
	Calcaire à Scyphies inferieur.	Spongitian.	
Callovian.	Le fer sous-Oxfordien.	Supérieur.	Callovian.
	Zone of *Amm. macrocephalus.*	Inférieur.	
Bathonian.	Dalle nacrée, etc.	Dalle nacrée.	

Some of the lithological and palæontological differences between these rocks and the English Oolites were noticed, and the views of Oppel, Marcou, Waagen, Blake, and Renevier, as to the relations of the beds in the two countries, were commented upon. The author then proceeded to compare the fossils of the Swiss Jurassic beds with those of their English representatives, stage by stage, and finally suggested the following correlation :—



2. "The Physical History of the Bagshot Beds of the London Basin." By the Rev. A. Irving, B.Sc., F.G.S.

The author, in reviewing the position taken up by him, attempted to estimate the value of such palæontological evidence as exists, and insists on the importance of the *physical* evidence in the first place. He gave reasons for considering the evidence of pebbles, pipe-clay, derived materials, ferruginous concretions, percentages of carbon (ranging in the more carboniferous strata up to nearly $2\frac{1}{2}\%$) taken together with the evidence of carbon in combination, as adduced in former papers, *freshwater Diatoms* (now perhaps recorded for the first time in the Middle and Lower Bagshot), and the microscopic structure of the sands and clays, as furnishing such a cumulative proof of the fluviatile and delta origin of the majority of the Middle and Lower Bagshot Beds, as can hardly be gainsaid; while he regarded the wide distribution of the Sarsens, taken along with the absence of such evidence as is quoted above, as indicating, along with the fauna, a much greater former area for the Upper Bagshot than for the strata below them.

He referred to the evidence furnished by the Walton section (Q.J. G. S. May, 1886), the Brookwood deep well (Geol. Mag. August, 1886), the contemporaneous denudation of the London Clay (Geol. Mag. September, 1886) as affording further support to the view which he has advocated; gave six new sections on the northern side of the area, showing (1) the attenuation of the Lower Bagshots beneath the Middle Bagshot clays, (2) the greater development of clays towards the margin at the expense of the sands, (3) contemporaneous transverse erosion of the London Clay, (4) cases of overlap, (5) the occurrence of massive pebble-beds at nearly the same altitude along the northern flank underlying (as at Easthampstead and Bearwood) Upper Bagshot sands, and resting either immediately upon, or in near proximity to, the London Clay; and added an account of his observations on the flank of St. Anne's Hill, Chertsey, which he takes to be nothing more than an ancient river-valley escarpment, subsequently eroded by rain-water, the hollows thus formed having been subsequently filled up and covered over by pebbles and other débris of the beds in the higher part of the hill, these assuming the character of ordinary talus material. The consideration of the southern margin of the Bagshot district is reserved for a future paper.

The author considered that his main position, resting as it does upon physical evidence, remains untouched by the attempt of later writers to disprove it; while the disproof breaks down even on its own lines (the stratigraphical), the paper in which this disproof is insisted upon being characterized by (1) an incomplete grasp of the problem on the part of its authors, (2) equivocal data, (3) omission of important evidence, (4) inconsistencies, (5) erroneous statements.

The author (while correcting some errors of stratigraphical detail, which appeared in his former paper, from insufficiency of data) maintained that (though occasional intercalated beds with marine fossils may be met with, as is commonly the case in a series of delta- and lagoon-deposits) the view he has put forward is, in the main,

established; and he proposed the following classification of the Bagshot Beds of the London Basin:—

Old Reading.	New Reading.
1. Upper Bagshot Sands	= 1. Marine-estuarine Series.
2. Middle Bagshot Sands and Clays 3. Lower Bagshot Sands	= 2. Freshwater Series.

(2).—February 9, 1887.—Prof. J. W. Judd, F.R.S., President, in the Chair.—The following communications were read:—

1. "Evidence of Glacial Action in the Carboniferous and Hawkesbury Series, New South Wales." By T. W. Edgworth David, Esq., F.G.S.

After giving a tabular statement of the sequence of rocks connected with the coal-bearing beds in New South Wales, the author passed in review the notices by previous observers of glacial action in the Carboniferous beds of that country, terminating with the discovery by Mr. R. D. Oldham of polished and striated boulders in fossiliferous marine beds of Carboniferous age at Branxton. The author had since found another extensive deposit of similar beds at Grass-tree near Musclebrook, 28 miles N.W. of Branxton, and described the section there exposed in a railway-cutting. A fine calcareous sandy shale, reddish to greenish-brown in colour, was crowded with round and subangular fragments of rock, from pebbles no larger than marbles up to a third of a ton in weight. The surfaces of these fragments were in many cases ground and scattered. The parent-rock of some of the boulders was 30 miles distant.

The evidence of ice-action in the Triassic Hawkesbury series was also described. This evidence was twofold, and consisted of the disrupted angular fragments of shale first observed by Mr. Wilkinson, and of contemporaneously contorted current-bedding, of which no account had previously been published. The contortions were represented on a diagram, and attributed to a lateral thrust such as would be produced by the grounding of floating-ice.

The discovery by Mr. Wilkinson of polished and striated boulders in some gold-bearing conglomerates, believed to be of Siluro-Devonian age, was also noticed.

2. "The Terraces of Rotomahana, New Zealand." By Josiah Martin, Esq., F.G.S.

The author, after deploring the recent calamity, proceeded to describe the *White Terrace*. Its origin, the Terata Geyser, was situated in a crater-like escarpment near the centre of a conical hill of steaming and partially decomposed felspathic tuff on the south-east side of the warm lake, Rotomahana. The Terrace was divided into:—

1. The Upper Terrace, with its long horizontal lines of cups, steaming and overflowing with hot water.

2. The Middle Terrace, with its massive steps and shaggy fringes, without basins or receptacles for the overflow.

3. The Lower Plateau, a series of shallow basins and wide, level platforms.

The great cauldron and the action of the Geyser were described

in much detail. The following analysis of the water was given in *grains per gallon* :—

Silica, free and combined with soda	50
Sodium and potassium chlorides	60
Alkalies, chiefly soda	30
Sodium sulphate, etc.	10
Total	150

The amount of rock-material withdrawn in solution would amount to about 10 tons per day; observations lead to the conclusion that 10 per cent. of the silica would be deposited on the surface covered by the overflow—equivalent to about 120 tons per annum. Then followed the description of the three divisions previously defined, including such local features as the *Gidnt Buttress*, the *Boar's Head*, and the *Broken Basin*—the latter a circular pool 12 feet in diameter and 30 inches deep—the only warm-water basin on the White Terrace of sufficient depth to be used as a bath. The central portion of the Middle Terrace was distinguished by a series of massive, rugged, and rippled perpendicular steps, many of which exceeded six feet in height, and were variously ornamented. The margin of the lower plateau was somewhat undefined towards the lake.

The author observed that the comparative study of local phenomena must precede any attempt to explain the origin of the Terraces. The phenomena of mud-volcanoes exhibited at the plateau of Rotokanapanapa afford to the geologist valuable indications of the probable appearance of the Te-Tarata cauldron in the earlier stages of its activity. These phenomena he described, and arrived at the conclusion that the initial activity of Te-Tarata was of a similar nature, and that the successive periods which mark the history of the formation of the White Terrace correspond with the increasing activity of its source. Given a crater-lake of seething mud, as activity increased, the outer wall of the crater would occasionally be broken down, and mud-streams would be liberated. Such periodical overflows he regarded as having built up the curious and complex terraced series. This hypothesis he applied in detail, and concluded that deposition and removal combined to produce the great variety of forms which existed. Thermal activity within the cauldron having at length removed the softened rock, the deposition of siliceous incrustation commenced.

Lastly he gave a short description of the Pink Terrace, and remarked that by the catastrophe of June 10th the waters of the lakes Rotomakirisi and Rotomahana were drawn into the new fissure at the base of Tarawera, whilst the Terraces were blown away.

3. "The Eruption of Mount Tarawera." By Capt. F. W. Hutton, F.G.S.

The paper commenced with a description of the country in which the eruption took place. From Tongariro to White Island, in the Bay of Plenty, a distance of 130 miles, there extends a belt, 20 or 30 miles wide, abounding in solfataras, geysers, hot springs, etc., and composed of volcanic rocks, chiefly rhyolite, with some augite-andesite. About the middle of this belt lie the mountain and lake

of Tarawera, and two or three miles further south Lake Rotomahana, the spot where the famous Pink and White Terraces existed. Before the recent eruption there were no craters on Mount Tarawera, the form of which was a ridge, apparently due to denudation.

Shortly after midnight on the 10th of June a series of tremendous explosions took place from various parts of the Tarawera ridge, and columns of steam were thrown up with quantities of red-hot stones. The whole mountain appeared as if on fire. A column of steam was then sent up from near Okaro far to the west, and, finally, a great explosion took place in Lake Rotomahana, and steam rushed forth to a height exceeding that of the columns from Tarawera. These eruptions from the plain were not accompanied by any red-hot stones; the ejecta were of much lower temperature. The principal eruption, accompanied by violent earthquakes and loud noises of various kinds, was over by 5·30 A.M., and the mountain craters ceased to be active within twenty-four hours, but steam with some stones and mud continued to issue from the Rotomahana and Okero craters for several days, and steam has ever since been emitted from Rotomahana.

The results of the eruption in the form of fissures on Mount Tarawera, the change of Rotomahana from a lake to a crater of larger dimensions, with precipitous walls, the formation of a new lake between this crater and Tarawera, and the formation of a number of small craters about Okaro, were then briefly noticed. The materials ejected were composed of augite-andesite, and rhyolites, both compact and vesicular. The mineral structure and distribution over the surrounding country of various forms of pumice, scoria, and ash were described, and it was shown that there was a difference in the substances ejected from the mountain craters of Tarawera and those from the craters in the plain at Rotomahana and Okaro, the former comprising pumice and scoria, which were not thrown out from the latter, and but little steam issuing from the higher craters when compared with the enormous volumes emitted from the lower vents. The cause of the eruption was ascribed to the reheating of old lava-streams saturated with water. This reheating was apparently not due to crushing; for, had it been so, the preceding earthquakes would have been more violent, but probably to molten rock coming up from below and heating the rocks near the surface. The eruptions from Rotomahana and Okaro were purely hydrothermal.

CORRESPONDENCE

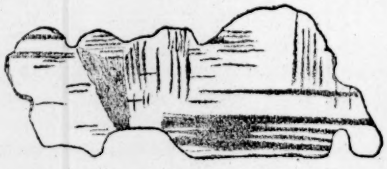
THE LIZARD SERPENTINES.

Sir,—As Prof. Bonney has called in question my statement that felspar occurs in the Rill serpentine, I should like to mention the grounds on which that statement was based. Of course there is always a certain amount of inference involved in the identification of minerals under the microscope. One recognizes a number of characters, and then one forms the opinion that those characters indicate the presence of a certain mineral.

Now I find in all sections of the Rill serpentine that I have examined irregular grains of a colourless mineral having the refractive index of felspar, so far as one can judge of this by the relief of the section and the character of its surface. This mineral always polarizes in the neutral tints of the first order in sections in which olivine and augite would give as a rule chromatic polarization. It frequently shows, moreover, a fine lamellar twinning, and sometimes two sets of parallel lamellæ may be seen intersecting each other at a high angle. It has been rendered turbid in places by granular decomposition products. Now I know of no mineral except felspar which possesses all these characters. Professor Bonney vaguely suggests that it is augite or diallage. I am, of course, aware that augite does show multiple twinning; but I cannot possibly regard this mineral as augite. In one case in which the extinction of the two sets of twin lamellæ were approximately symmetrical with reference to the trace of the face of composition, the combined angle was 53°. Now, if the crystal were augite, twinned according to the ordinary law, such a section could not possibly be cut approximately at right angles to an optic axis;[1] and, therefore, in slides of the thickness used, could not possibly polarize in the neutral tints of the first order, as it actually does.

Another very important point is the existence of two sets of lamellæ intersecting at a high angle. This is perfectly easy to understand on the assumption that the mineral is felspar; but, so far as I know, inexplicable on the assumption that it is augite.

To sum up. As the mineral possesses the refractive power of felspar, the double-refraction of felspar, the twinning of felspar, and the mode of alteration of felspar, so far as we are able to judge of these characters under the microscope, I adhere most firmly to my original statement.



Section of felspar in the Rill serpentine, showing cross-twinning; Nicols crossed. Magnified 80 diameters.

In my remarks on the Rauenthal serpentine I have simply followed Weigand, and I must leave him to take care of himself, as, no doubt, he is well able to do. I may remark, however, that the main point of Weigand's paper, so far as it relates to the Rauenthal rock, is to prove that serpentine has been largely produced by the alteration of hornblende, and that the serpentine so formed can be distinguished from that produced by the alteration of olivine. The slides of specimens purchased from Sturtz amply

[1] On referring to Fouqué and Lévy (Min. Micrographique, p. 355), it will be seen that the section in question, if of augite, would be out of the zone 100 : 010 and would make an angle of about 35° with the ortho-pinacoid.

confirm Weigand so far as this is concerned. It must be remembered that Weigand's paper appeared in 1875, at a time when the notion that all serpentines were altered olivine-rocks was becoming very general in consequence of the researches of Sandberger and Tschermak, published some eight or nine years previously.

I may take this opportunity of referring to Col. McMahon's paper in the same number of the GEOLOGICAL MAGAZINE. I have no new facts of any importance to add on the subject referred to, and I do not think that any useful purpose would be served by my attempting to remove the objections raised by Col. McMahon. I cannot explain why foliation has been developed in some cases and not in others. The apparently capricious manner in which foliation comes in is equally striking in the Scourie Dyke and in the Lizard gabbros. If I am right in one case, I am right in the other; and if I am wrong in one case, I am wrong in the other. I believe with Col. McMahon that foliation may be produced in connexion with the intrusion of plutonic rocks; but I cannot explain the foliation of the Lizard gabbros in this way.

Col. McMahon quotes Prof. Bonney as saying that the serpentine is "free from all signs of disturbance." This is true of the serpentine locally, as it is of the gabbro; but it is not true generally. There are the same signs of disturbance in the serpentine as there are in the gabbro. I have a polished slab of serpentine from Porthalla, which shows precisely the same structural features as the figured slab of augen-gabbro from Karakelews. Abundant signs of pressure metamorphism occur also in the serpentine near Mullion Cove.

J. J. H. TEALL.

BORING AT BLETCHLEY.

SIR,—The London and North-Western Railway Company have for some time been carrying out a trial-boring for water; and if they have not found what they were in search of, they have made a discovery which is interesting to geologists in reference to the underground structure of the central and eastern parts of England. I have not yet the full details before me; but, from the information furnished by Mr. C. Bowen Cooke, it would appear that the boring-rods, after penetrating the Jurassic Clays (called by my informant the "Oxford Clay"), struck on a very hard rock, of which three small specimens were sent to me for identification. On examining them I had no difficulty in giving a reply. The specimens appear to consist of finely-crystalline quartz-felsite, with some green mica, and evidently form a portion of the old Pre-Triassic ridge, which, as all underground borings combine to prove, underlies the Mesozoic formations of this part of England.

I hope ere long to have a complete series of the cores brought up from the boring, and to be able to give fuller details.

GEOL. SURVEY OF IRELAND,
14, HUME STREET, DUBLIN.

EDWARD HULL.

THE PEA GRIT OF CLEEVE HILL.

Sir,—I thank Mr. Witchell for his courteous correction of my figures in the thickness of the Pea-grit, and underlying Ferruginous Oolite in the Cleeve Hill Section, which I quoted in my letter in the Geological Magazine for November last. The error occurred in the numbers of the beds being inserted as feet, and the three figures were transferred to the inch column. Mr. Witchell remarks that "the correct reading confirms my statement, except as regards the lowest 5 feet." Exactly, but the exception makes all the difference; if there are only 5 feet of Oolite under the Pea-grit beds at Cleeve Hill, then Dr. Wright could not make the thickness more, and as I understand Mr. Witchell, in his paper in the Quarterly Journal of the Geological Society, he maintains that the basement beds were overlooked by Dr. Wright. Mr. Witchell in his paper says, "The beds next above the Cephalopoda-bed are usually brown sandy limestones in two or three beds, varying in thickness from 5 feet at Cleeve Hill." [1]

Now I think it would have been fairer to Dr. Wright if Mr. Witchell had given a reference to Dr. Wright's Cleeve Hill section where that fact was first mentioned. Doubtless in the Stroud area the basement beds assume a greater importance than Dr. Wright recognized, but of course he had to be guided by the available exposures of the strata in his day.

I do not think I need argue the matter further, as Mr. Witchell seems to me to admit my contention, viz. that the late Dr. Wright in his sections of Cleeve Hill and Leckhampton showed that there were Oolitic beds below the Pea-grit proper. Edward Wethered.

THE COLLINGHAM OR SCARLE BORING.

Sir,—The alternative figures, given by me, as Reporter to the British Association Underground Water Committee, on the authority of Mr. W. H. Dalton, are correctly copied from a lithographed copy of a report by him to the Gainsborough Board of Health, "On the Water Supply obtained from Underground Sources at Gainsborough," handed to me by the Board on the 24th of October, 1884, and now before me.

On the 1st of November, of that year, I recommended the Board to sink an artesian boring at Gainsborough to a depth of 750 feet: this proposal was adopted, and I have to-day learnt by telegraph that the contractors, Messrs. Timmins, of Runcorn, have penetrated the Keuper Marls, and reached the Sandstone at a depth of 725 feet from the surface.

C. E. De Rance.

54, West Parade, Rhyl.

FOLKESTONE GAULT.

Sir,—Mr. John Griffiths, of Folkestone, the well-known collector of Gault fossils, is without resources and is permanently disabled by rheumatism brought on by exposure in his daily labours, which have

[1] Q. J. G. S. vol. xlii. p. 267.

not only enriched the Museums of Europe and the United States, but have formed the groundwork of the investigations into the *zones* and *fossils* of the Gault made by myself, and fellow-workers—the Rev. Professor Wiltshire before my own endeavours, and those of Mr. F. G. H. Price, F.G.S., and Mr. Starkie Gardner, F.G.S., since. Mr. F. G. H. Price, of Messrs. Child's Bank, Temple Bar, W.C., has kindly undertaken to receive subscriptions for the "Griffiths Fund."

H.M. Geological Survey. C. E. De Rance, F.G.S.

OBITUARY.

CALEB EVANS, F.G.S., MEMB. GEOL. ASSOC.

Born July, 1831; Died Sept. 16, 1886.

The subject of our present Memoir was a resident of Hampstead. He was educated at University College School, and so early as in 1846 he entered a solicitor's office, and was appointed Clerk in the Chancery Pay-Office in 1852, where he served for 30 years, but retired on account of ill-health in 1882.

He commenced to study geology about the year 1855, and attended lectures by Prof. Owen and Dr. Melville. He made no actual collection of specimens until 1858, but from that time until his health gave way, he took advantage of his annual official vacations to visit the various localities of geological interest, especially those of the South-East of England. In 1859 he became a member of the Geologists' Association, and in 1867 he was elected a Fellow of the Geological Society of London. The beds to which he chiefly directed his attention were those of the English Tertiaries and the Chalk, and in addition to a large collection from the Isle of Wight and Hampshire beds, he obtained numerous London Clay fossils by watching the excavations in various parts of the Metropolis, and more especially from the main-drainage works in the South of London, which yielded numerous fossils of the Woolwich and Reading Series, from strata then exposed for the first time, and which have never been accessible since in this particular area.

Mr. Evans was author of eleven papers, eight of which appeared in the Proceedings of the Geologists' Association, the most important being that "On the Geology of the Neighbourhood of Portsmouth and Ryde." But the paper by which he will be best known was that read before the Geologists' Association in January, 1870, entitled, "On some Sections of Chalk between Croydon and Oxtead," which was separately published. It was the first attempt made in this country to subdivide the Chalk into zones according to their fossil contents, and to correlate these zones with those in other parts of England and on the Continent.

Mr. Evans constructed several geological relief-maps or models, based on his own observations; one of the neighbourhood of Hampstead and Highgate; one of the Thames Valley in the neighbourhood of London; one of Hastings, one of Sidmouth, and one of England

and Wales. Although Mr. Caleb Evans only attained the age of 55 years, he has left behind him a very excellent record of geological work achieved by a private individual in the leisure hours of a busy life.

JOHN ARTHUR PHILLIPS, F.R.S., V.P.G.S., F.C.S., M.I.C.E., ETC.

BORN NOVEMBER, 1822; DIED 5 JANUARY, 1887.

THE new year has deprived us not only of an excellent chemist, mineralogist, and geologist, but of a dear and valued friend. Born at Polgooth, near St. Austell, where several of his family had been connected with that important tin-mine, young Phillips inherited a love of mining and metallurgy which he retained unabated to the end of his useful and valuable life. His school-days were passed at St. Austell, but he does not appear to have developed a love for science until near his 20th year, when the subject of electro-metallurgy attracted John Arthur Phillips' attention, and he exhibited some specimens of electro-deposited copper on lace, for which he received the first prize from the Royal Cornwall Polytechnic Society in 1842 at Falmouth.

This led to a series of investigations into the formation of mineral lodes. But the want of more accurate scientific training led him to Paris in 1844, where he entered as a student at the École des Mines. Here he passed through the regular course of study, and showed such proficiency that he obtained the appointment of engineer to one of the large French Collieries, which he held for some years. On his return to England, he was engaged by Sir Henry de la Beche and Dr. Lyon Playfair to carry out experiments at Putney for the Admiralty, on the various qualities of coal suited for the steamships of the Royal Navy. Lead-smelting and desilvering works next occupied his attention. Thence he went to California on an inspection of the gold-producing regions, and to report upon the machinery and methods in use in separating the precious metal at gold-mines and works. On his return to England, he lectured before the Society of Arts, on May 14th, 1862, on "Gold-Mining," giving the result of his own experience and observations in America. Mr. Phillips published his "Manual of Metallurgy" in 1852, a second edition in 1854, and a third in 1858. At the time of his death he was engaged upon a fourth edition assisted by Mr. Bauerman, which we understand will be almost immediately published. Mr. Phillips was also the author of a work on "The Mining and Metallurgy of Gold and Silver," which appeared in 1867. In 1884 he published his "Treatise on Ore-deposits," giving all the varied natural phenomena connected with the occurrence of metalliferous deposits.

For the last sixteen years Mr. Phillips has mainly directed his attention to the study of petrography, and his paper in the Quarterly Journal of the Geological Society, "On Concretionary Patches and Fragments of Rocks found in Granite," and others of a kindred nature, are of the greatest value to petrologists.

His communications were not however confined to the Geological

Society, but were made also to the Chemical and the Royal Societies, and some were published in the Philosophical Magazine. He was elected a Fellow of the Geological Society of London in 1872, and of the Royal Society in 1881, and at the time of his death was a Vice-President of the former Society. He was also a F.C.S., a M.I.C.E., and an "Ancien Elève de l'École des Mines."

Those who were personally acquainted with Mr. Phillips, while they lament the loss to science which his sudden death has inflicted, mourn still more the extinction of a life of singular simplicity, earnestness, and kindliness. He was a large-hearted and open-handed man, fond of taking every chance that came in his way of doing a good deed and helping every one to whom his help could be of service.

CHARLES FRANÇOIS FONTANNES.

Of the losses by death sustained by Geological Science in the year 1886, none has been greater than that of M. Fontannes. Men of riper age, and of wider reputation, we may have lost; but when we consider the value and the amount of the work performed by M. Fontannes before reaching his 48th year, it will be evident that the gap left by his death will not be easily filled. Especially will this be the case with the "International Geological Congress," which is to hold its next meeting in England in 1888.

There are several Secretaries to the Congress at each meeting, but the bulk of the work falls on one or two. At Bologna, in 1881, M. Fontannes divided the work with M. Delaire; but in 1885, at Berlin, M. Fontannes took it almost entirely upon himself. The "procés verbal" of a foreign scientific meeting is very different from the "minutes" of an English meeting; it is really a full abstract of the entire discussion, and the prompt preparation of this is no small test of a man's powers.

M. Fontannes' earliest work was a notice of the Museum of Lyons, 1873. This was followed in 1874 by a Note on the Infra-Lias of Narcel, and by notes taken at Athens. In 1876 he published, with M. Dumontier, "Description des Ammonites de la zone à *Ammonites tenuilobatus* de Crussol et de quelques autres fossiles Jurassiques nouveaux ou peu connus" (*Mem. l'Acad. Lyon*). In 1879 this was followed up by a work on the same subject by Fontannes himself, Dumontier having died meanwhile. In the Introduction to the later work Fontannes pays a warm tribute to his late master, attributing to his encouragement and influence his own love for geology. These books made known a new Jurassic Fauna for the South-east of France.

The most important works by Fontannes were "Les Invertébres du Bassin du Sud-est de la France—Les Mollusques Pliocènes de la Vallée du Rhône et du Roussillon," of which two volumes appeared (1879-82); and "Etudes stratigraphiques et paléontologiques pour

servir à l'histoire de la Période Tertiaire dans le bassin du Rhône" (*Ann. Soc. Agric. Lyon*) ; of this eight parts appeared :—

i. Le Vallon de la Fuly et les Sables à Buccins des Environs d'Heyrieu (Isère) 1875.
ii. Les Terrains tertiaires supérieurs du Haut Comtat-Venaissin (Bollène. St. Paul-Trois Châteaux. Visan) 1876.
iii. Le Bassin de Visan (Vaucluse) 1878.
iv. Les Terrains néogène du Plateau de Cucuron (Cadinet-Cabrières-d'Aigues), 1878.
v. Description de quelques espèces nouvelles ou peu connues, 1879.
vi. Le Bassin de Crest (Drôme), 1880.
vii. La Région Delphino-Provençale, 1881.
viii. Le Groupe d'Aix dans Le Dauphiné, La Provence et le Bas-Languedoc, 1885.

An active worker in the field and a careful student in the museum and library, M. Fontannes united in himself the two important requisites for studying problems of this nature. He explored the later Tertiaries of the South of France and the neighbouring regions, wherever known, and traced them into districts where they were not previously known to exist.

Besides the important works here alluded to, M. Fontannes published numerous papers on the same or on kindred subjects, chiefly in the *Bull. Soc. Géol. de France* and *Ann. Soc. Agric. Lyon.* But he also wrote on the Miocenes of Portugal (*Ann. Sci. Géol.* 1884) ; on the Constitution of the Subsoil of the Chalk and of the Plain of Avignon (*Bull. Soc. Géol. France*, 1884) ; on Borings in the Isère, Drôme, and Vaucluse (*Ann. Soc. Agric. Lyon*, 1883). His minor and miscellaneous papers amount to about forty in number.

M. Fontannes was an Officer of Public Instruction, and of the Geological Survey of France ; Chevalier of the Order of St. Maurice and Lazare, and a recipient of other Orders conferred by Foreign Governments. In recognition of his important researches, the Academy of Sciences awarded him, in 1883, the Grand Prize of the Physical Sciences. W. Topley.

THE EARL OF ENNISKILLEN, D.C.L., LL.D., F.R.S., F.G.S., M.R.I.A.

Born 25 January, 1807 ; Died, 12 November, 1886.

By the death of William Willoughby Cole, third Earl of Enniskillen, geological science has lost one of its most earnest supporters. Educated at Eton, and afterwards at Christchurch, Oxford, he became attached to Sir Philip de Malpas Grey-Egerton, Bart., and having studied geology with him under the Rev. W. Conybeare and Dr. Buckland, they spent their long vacation with the former at Lyme Regis, where they made the acquaintance of the well-known Mary Anning, and commenced to collect Lias fossils. Afterwards, by advice of Dr. Buckland, they visited Franconia, and explored the caverns of Küloch, Rabenstein, Scharzfeld and Gailenreuth, and returned laden with spoils of Hyæna, Bear, Lion, Rhinoceros and other cave-animals. Encouraged by Prof. Agassiz, they took up the study of fossil Fishes, with which their names will ever remain associated. It seems only appropriate that the collections made by these two eminent palichthyologists, whose life-long friendship was cemented by a common interest, should now rest side by side in the Geological Gallery of the British Museum (Natural History).